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April 4, 1929

Engineering News-Record

Devoted to Civil Engineering and Contracting

BUILDING WITH MACHINES

IN THE days when hand machines dominated construction the job had to be planned on a man-hour basis. Today the tremendous development of power tools and machines has placed construction on an entirely different footing. New problems have been created. No engineer or constructor can afford to be unfamiliar with any phase of them. How is the art of construction meeting these problems and what are its present trends? An answer to some of these questions is attempted in articles in this issue, which brings together the thoughts of leading machine builders, contractors and engineers. This group of articles should assist in the development of the new mental attitude necessary if we are to build efficiently with modern machinery

Advance in Equipment Engineering - - - - - - - By E. H. Lichtenberg
Electric Power Possibilities for Construction Equipment - - - By R. C. Muir
Motorizing the Hand Tool - - - - - - - - - - By C. H. Vivian
Equipment Standardization an Economic Need - - - - - - By C. S. Embrey
The Equipment Factor in Estimating Costs - - - - - - By A. H. Hunter
Practical Advantages of Standardizing - - - - - - - By F. L. Copeland
Epochal Developments in Equipment Engineering - - - - By R. Burdette Dale
Credit Reform Demanded in Time-Payment Sales - - - - By S. M. Williams
Concrete Mixer Improvement and Progress - - - - - By J. E. Bushnell
Economics of Diesel-Powered Construction Equipment - - - By L. H. Morrison
Power Shovel Development - - - - - - - - - - By J. G. Miller

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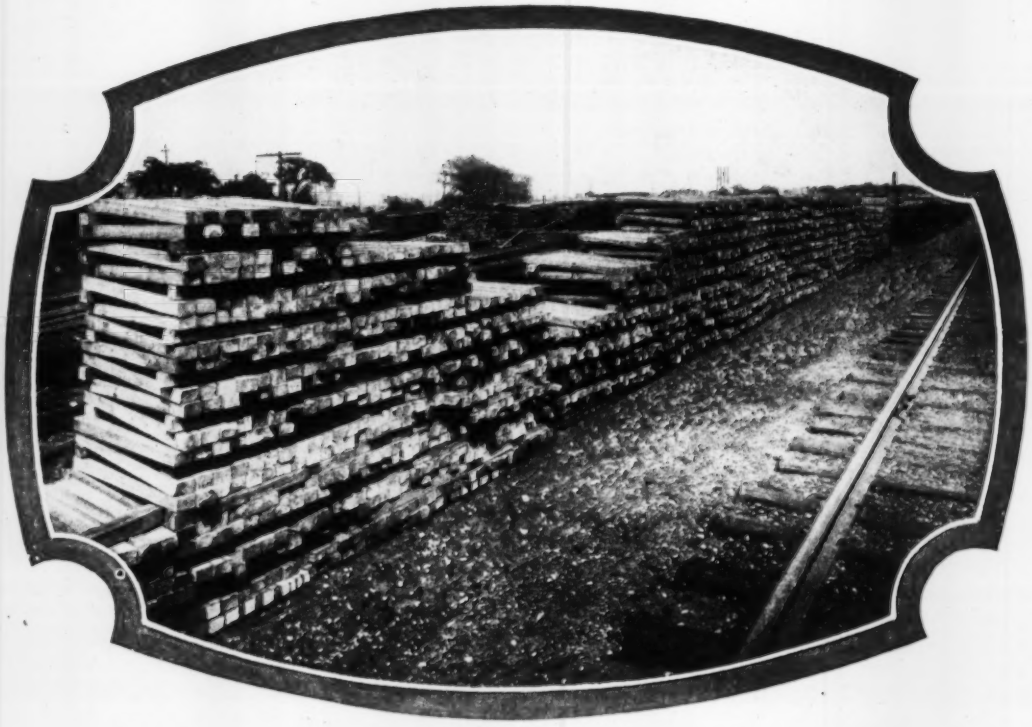

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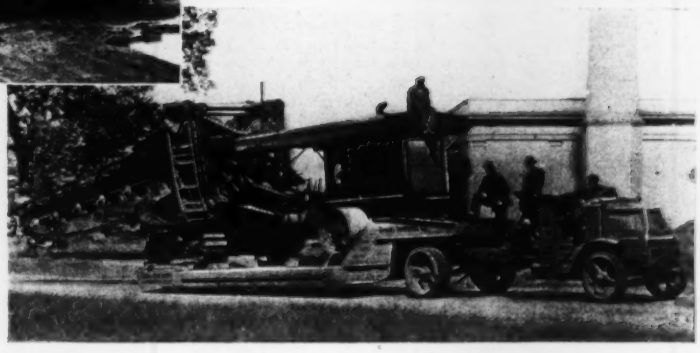

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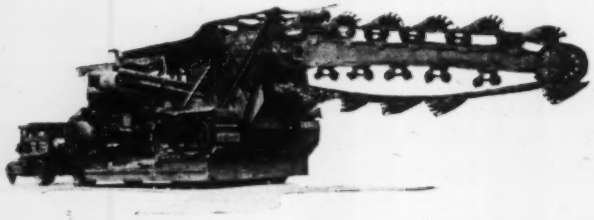

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Building by Machine

Modern Construction WITHIN the memory of men yet in their prime, civil engineering has attained to a wealth of resource and a degree of productivity that are truly magnificent. If we attempt to search out the secret of this achievement, we are likely to find it in the same basic influence which converted the laborious handicraft production of past ages into the prodigious manufacturing system of the modern world. That influence is mechanical power, and the associated human inventiveness by which power was applied to useful service. Whatever we build today is a product of power, above all. The advance of the past few decades is distinguished by the marshaling of new agencies of power and by the creation of a multitude of new machines for making this power serviceable in construction. The immediate future promises to be marked by the same characteristic.

Mastering Power Tools BECAUSE of this vast influence of power on construction, one major group of the civil engineer's problems centers in the power tools which are the means of converting his plans into reality. The evolution of these tools has gone on almost too fast to allow his thinking to keep pace with it. A more thorough appreciation of the machine's function in modern construction and a mastery of the art of gearing together the man and the machine ought to be the objective of the immediate future. With a view to this objective, the editors called on a number of leaders in the field of construction machinery to set down their observations on problems arising from the use of power in construction. The present issue contains their contributions. Much more needs to be written on the subject, and we therefore hope to continue the work in future issues. With the active co-operation of those who build and those who use construction machines, such discussion of problems can serve effectively toward creating the needed fuller understanding of the art of building by machine.

The Human Interaction IF THE productivity of modern construction is mainly to be credited to the power machine, the brilliant resource of the present-day art is the associated contribution of the engineering brain. Works that not long ago were beyond the range even of fancy are not only possible but commonplace—buildings, bridges, dams and tunnels of unexampled size and difficulty. Such performance is the product not only of better machines but also of greatly increased knowledge and skill. But each new possibility of construction which was opened up by a new development on the part of analyst or designer called forth almost simultaneously more efficient materials and tools; and quite similarly each new and more powerful tool enlarged the scope of the engineer's conception of method and structure.

Because of this interaction between the mechanical and the human factors of engineering, it is the more vital that the problems of applying this machinery as a well co-ordinated part of the construction art be studied. Future engineering progress will be stimulated by adequate machine study; without this it is in danger of languishing.

Aspects of Equipment Progress

Results of Growth RAPID growth in variety and quality of machines for construction has been particularly notable during the last ten years. At least some of the impulse toward the development resided in the tremendous increase in construction since the war, with its aftermath of increased wages and prices. The machines of the previous decade or generation were transformed by radical changes in power units, transmission and radius of operating movement. The implications of this transportation extend throughout the construction industry. Machinery, its production and merchandising as well as its operation on the job, has changed the whole aspect of engineering work and created for the constructor intricate problems of plant financing and management. All of these developments are indicated in the half-score of articles which make up this issue. They confront the reader among other things with the question of what this sublimation of machine work has done for engineering construction.

What Has Been Gained IS THE builder of structures, whether public body or private owner, getting more for his investment dollar because of the machine age in construction? It is safe to affirm that he is, but much less easy to assign specific dollars-and-cents values. A direct comparison with older conditions requires so great a reduction to elementary operations and such extensive equalization of working conditions that specific values are unconvincing. Generalizations are easier and also more reliable.

In the sense that time is money, enormous savings can undoubtedly be credited to the greater use of machines in construction. Speed is so pronounced a manifestation of present-day building that it is indisputable. Machinery has made speed possible, by reducing the time cycle of construction processes and by extending the seasonal and daily time when work can be done. Night is made like day and storm is made like fair weather by the equipment that the constructor can call to his service. Modern engineering has, of course, contributed other aids than machinery to rapid building; it has brought new materials and methods. But steel and concrete and fabricated units are made possible of quick combination into structures by the riveting hammer, the mixer and hoist, and the welding unit.

It has with faster work brought better work. The tradition of the sublimity of artisanship to the contrary.

machines are building better structures commonly than were produced rarely by hand labor in times past. Precision of surface and line, solidity of connections and all fabricating processes requiring sustained power are improved. If the time factor is included, there is no question of the superior product of the machine. In general the machine calls a higher construction talent into service. Plant management requires a higher quality of brain and training and there follows sharper pride in technical accomplishment and a keener sense of responsibility for financial worth.

Place for Management THERE follows also, with the gains to construction through machine performance, a new line-up of problems for the constructor. As a plant manager he has to scheme out his plant assemblages with an eye to investment cost, co-ordination, standardization, depreciation and suitability, and operate them at the least expense for upkeep, rental, fuel and supplies and moving and storage. All this he must do, moreover, with clear perception that he is in business for profit rather than to develop niceties of plant management. The task is complex and requires an understanding co-ordination with equipment production and merchandising practices. Ways and means of performing this complex task are offering many obstacles, but there is assured compensation for its successful accomplishment.

A rather astounded conviction of the scope and complexities of equipment engineering will come to anyone who traces the progress of the art closely. Even most engineers will have a new conception forced upon them by the half-score of equipment specialists who ask attention in the following pages. Nothing happens or has happened by chance in this field, any more than in bridge engineering or hydraulics; development and improvement are studied results. Nor will the development of efficient management of equipment come about as a chance result. It, too, must have intimate study.

A Joint Interest IT IS of great interest to contemplate the wide extension of power machines to all operations of construction, to little tasks of the hand as well as to movement of great masses and volumes. The phenomenon is quite as impressive as the creation of equipment engineering as a special branch of the art. Even with clear knowledge of the recent remarkable progress in equipping construction operations it yet is often astonishing to observe its extent. In so complex an operation as laying a concrete pavement it is not uncommon to find every operation of handling materials and laying slab, and even the final charting of its smoothness, performed by machine. There are workmen, but they pull levers instead of pushing shovels.

Because of this broad range of influence, because of the potency of machinery in present-day construction, and also because of the new problems which it brings forth, the subject is obviously tied up with general business and with professional engineering, and wide co-operation in dealing with it is essential. The engineer and the owner have a definite stake in sane credit terms, in standardization and in capable plant engineering generally. They occupy a position where they can exert a legitimate influence in specifications and contract requirements; and for their own proper advancement they must bear their share of the problem. It should no longer be the sole task of the contractor and the equipment maker to carry on unsupported.

Two Questions of Today

Obsolete Equipment OF THE numerous issues that are before the construction industry because of the increasingly important machine factor, there are two of immediate urgency. First is the matter of obsolescence, and the associated question of standardizing to reduce its influence.

Contractors have become well acquainted with obsolescence in recent years. Industry at large has been familiar with it for a much longer period. Steelmaking, cement production and almost every process of manufacturing has its periods of discarding still productive machinery because it can no longer compete with newer inventions. Indeed, no machine process has yet reached the period when obsolescence has ceased to be a depreciation charge. The case with construction is that it has so recently become a machine process that the new cost item presents a strange face and also has been so persistent a guest of the contractor that he is rather worriedly casting about for a way of showing him the door. There is no such simple solution. Obsolescence cannot be kept out of the accounts; but its amount may be reduced enough to make the issue less troublesome.

When to Standardize SOMETHING may be done by standardization, as is indicated by C. S. Embrey in this issue, but this possibility comes only when the tool or machine has evolved through improvement to a form which fairly perfectly fits the purpose. Until then changes are radical; afterward improvement is a gradual process of bettering details, and thereafter simplification and standardization as defined by Mr. Embrey have an opportunity. The important part of this definition is that it makes clear that standardization as exemplified by concrete mixers can proceed far toward saving money for both users and producers without in any material manner hampering the freedom of mechanical or functional improvement. In the recent years when mixers have been "standardized" there has been perhaps greater increase in perfection than in any previous equal period of time. Many other lines of construction equipment need the same curb of simplification and standardization, and equipment makers can do few other things of more benefit to the industry than to study these possibilities with open minds.

Credit Reform THE SECOND question is that of reestablishing sound credit practices in the construction equipment field, as discussed by S. M. Williams. That the present situation is thoroughly bad is well recognized. Why is reform so difficult? The reasons are fundamental. There is overproduction of equipment and competitors must sell to live. Contractors find easier bankers among equipment manufacturers than in the money marts. Tremendous programs of public and private works have created a bull market in construction. A speculative business has replaced straightforward merchandising both in marketing the contractor's services to the owner and in selling the manufacturer's equipment to the contractor. The result is a growth of bad business habits which are bound to be eliminated either by the reform or by the extermination of those who are responsible for them.

Already the mortality is great among contractors. Can it be long delayed among the equipment merchandisers? Exhortation of the equipment merchant to protect his

customer and to help stabilize the construction industry has been sounded many times and is repeated by inference in Mr. Williams' article. The seller needs rather to be adjured to care for himself. If he faces nothing worse, elimination by merger confronts him. A sharp decline in construction activity, and it cannot always be at peak, will cut away his present margin of credit safety. Present credit practices are a gamble in futures—they are dangerous. The power of reform lies with the merchandizer alone—he is the seller and he can set the price. It is time that he did so and made it profitable to himself and uniform to his customers.

Notes of the Week

Construction and Confusion WITH the end of the first quarter of the year come most gratifying figures of sustained activity in the construction field. The total of engineering and residential construction exceeds that of 1928 (first quarter) by 8 per cent; residential work decreased heavily, probably because it had run ahead of its market, but heavy construction leaped ahead of last year by 42 per cent! Since public services are by no means adequately provided for as yet, it is reasonable to expect a high rate of construction to continue. A specially interesting point is that at this very time an active argument has developed about stock speculation, and that some may fear a reaction on the availability of money for construction. Nothing has appeared to warrant any such fear, as we see the situation, nor is it to be expected unless general confidence is shaken by violent throttling of credit, whether spontaneously by a panic or deliberately as in the farm-deflation days of seven or eight years back. Confusion may reign in the stock exchanges without affecting the basis of sound production or construction activity.

A Rapid Transit Vote DETROIT'S vote of the people on a well-conceived beginning toward rapid transit ended in another disappointment. For that rapidly growing city nothing is of greater present importance than purposeful action to improve the ease and speed of transportation in its widely scattered industrial area. The need was foreseen a decade ago, and for six years a systematic study and wise planning based on ample experience in matters of city development and rapid transit have been under way. Through this study a general project, too large for present realization but serving as an excellent base plan, was perfected three or four years ago, and since that time the effort has been to work out an adaptation of the most useful present part of this project to the financial resources of the city. The result was the plan submitted to referendum vote of the people early this week. It proposed an east-west subway line and two short sections of future through lines extending respectively north and northwest from the city's center, these latter sections to serve for the present as a means of taking the street cars off the surface in the congested districts. The proposal was to pay for part of the cost through local benefit assessments, part through general city taxes, and part through fares—an eminently equitable arrangement, far in advance of anything yet carried out in rapid-transit construction in American cities. But, most unfortunately, there was pretty complete failure to organize a campaign for bringing the issue fully to understanding and acceptance. This seems to be the reason for the defeat of the proposal. Rapid transit must come in Detroit, and come soon, but with repeated failure on the part of civic interests to obtain the support of the people, its realization may be delayed so long as to work injury to the city.

The Only Safe Course FOLLOWING quickly after the decision to rebuild the suspension span of the Mount Hope bridge came a similar decision for the Detroit bridge, both being motivated by the mysterious cable-wire breakages reported last week. Though at Detroit the breakages had not reached an alarming extent, the example of Mount Hope supplied a ready and sensational picture of what might develop. Such a picture is clearly incompatible with any conception of demonstrated public safety. Not only could the confidence of the traveling public not be counted upon—which in a toll bridge project is obviously a vital consideration—but the bridge would lack that engineering guarantee of dependable strength which must be built into every structure. The decision to rebuild the cables, thus, was the only safe course. It is a foregone conclusion that the rebuilding will be so executed as to give complete assurance of safety of the two bridges concerned. Nevertheless, thorough research into the mysterious phenomena of the wire breaks is of utmost importance. Without such study and its successful conclusion, the advance of engineering science will leave a danger spot in its rear. Though the material involved was slightly different from that ordinarily used in engineering construction, its failure has a sufficient bearing on the general dependability of material to require complete clearing up.

Hidden but Important INCREASED activity in airport construction, which seems a certainty for the current year, means increased responsibility for the city engineers and the consultants who have entered into this work. This responsibility is the greater because of the lack of definite knowledge on many subjects incident to airport development. Some of the fundamentals, however, are not subject to uncertainty, since they represent old and tried methods of civil engineering construction. The most important is drainage. Its vital relation to airport success is generally realized, yet certain tendencies of the moment must be noted. The average citizen expects that shortly after the smoke of the local campaign for airport funds clears away he will see an elaborate layout of hangars, runways and terminal structures. With more intense competition for air business between cities, this desire for a "show-room" airport increases proportionately, and there is serious danger that pressure will be brought to bear upon the engineer to spend his funds for facilities that can be seen. Under these conditions a makeshift drainage system is likely to be installed. Such a tendency is dangerous. While underdrainage does not add to the esthetics of an airport, it does make a landing field, which is a more important requisite. It has been truly said that a landing field does not make an airport. But it is equally true that an airport is not even a good landing field unless its surface is dry and compact under all weather conditions. Every engineer responsibly connected with aviation should foster a wide appreciation of the physical structures that must be placed beneath an airport. It is no light responsibility to spend available moneys for drain pipe when the public wants plate glass windows in the airport station buildings.

Motorizing the Hand Tool

There Is a Power Tool for Virtually Every Hand Tool Task—Speed and Perfection of Work Are Increased and Costs Are Decreased, the Strain on the Workman Is Less and His Earning Power Is Greater

By C. H. Vivian
Ingersoll-Rand Company, New York City

The power tool has been one of the most notable developments in a generation of equipment invention. In all tools having reciprocating action the power tool is virtually the pneumatic tool. The variety of purposes that it serves is difficult of realization even by those who daily use some of its forms. The present article is intended to give by pictures an idea of pneumatic tool uses and by performance and cost records an estimate of pneumatic tool efficiencies. In presenting these facts of one line of tools the article is presenting them for all lines. This generality of conclusion should be kept clear, even though for practical reasons it has been necessary to use specific examples

POWER - OPERATED tools are now available for many construction operations that were formerly performed entirely by hand. Their widespread and rapidly growing use, the constantly widening scope of their application and the frequent additions of new types bear witness to the important place these tools occupy in the construction industry and forecast their increasing importance in the future. It is not the purpose of this article to describe such tools and machines in detail, but rather to discuss their utility. Their advantages are mainly three:

1. The saving in cost on most operations is pronounced. Let it be noted that all comparisons of costs cited here concern actual operations and are therefore something more than estimates.

2. On a few classes of work there is sometimes little saving from a dollars-and-cents standpoint, but the quality of work done by machine is unmistakably superior to that done by hand.

3. In other instances mechanical operation permits the thorough performance of work which can be done but poorly if at all by hand methods.

Portable Compressor Development Vital

Air tools are considered specifically. Obviously without a dependable, convenient and quickly accessible source of air supply their use would be greatly restricted. While stationary compressors have been and are being used on construction work, the growth in the use of pneumatic appliances during recent years is unmistakably due to the development of the modern portable compressor. This has taken place in eighteen years.

Standard portable compressors are made in various sizes, the larger having capacities of around 300 cu.ft. per minute piston displacement at 100 lb. air pressure. The present tendency is to express the capacity of the units in terms of the work they will do. For example, a 300-cu.ft. machine will operate eight paving breakers or nine backfill tampers or eleven medium-size calking hammers, etc. This method of expressing the ratings enables the user quickly and accurately to determine the proper size of machine to fit his needs. Portable compressors are available on various types of mountings and are arranged for either gasoline engine or electric motor drive. Except by electric traction companies, power plants, etc., where a convenient supply of electricity is at hand, gasoline drive is generally used.

CALKING A PIPE JOINT

Trenching and Pipelaying

Large concerns are traditionally the forerunners in trying out new appliances. Once they have proved their economy and efficiency, the industry adopts them for general use. A gas company that has been using pneumatic tools for trenching and laying gas mains since 1919 furnishes interesting comparative costs on mechanical and hand methods. A great varietv of work is done, such as tearing up sidewalks, asphalt pavement, concrete pavement and concrete sub-base, rock drilling prior to blasting, breaking masonry to enlarge manholes, picking ground, backfilling trenches, calking pipe joints, cutting cast-iron pipe and pipe tapping. The operating conditions are often severe.

This company has found that two men with paving breakers accomplish as much as 40 men with hand tools. The wages of two operators are $8 per day and the overhead on the paving breakers and one 5½x5-in. portable compressor is $16.96 per day. This latter figure includes interest, depreciation, operating expenses and repair allowance.

On rock-drilling work it has been found that each air-operated drill will average 9 ft. of hole per hour at an over-all cost of $1.55, or at the rate of 17c. per foot. Compared with this, one man at $4.80 per day with a hand drill averages 6 ft. of hole per day, or at the rate of 80c. per foot.

This company finds that on backfilling work two shovelers and one man with a pneumatic tamper will

TAMPING A DIFFICULT UNDERFILL
Showing facility with which tamping can be done under pavement where far parts cannot be reached by hand tool.

GRINDING DOWN HIGH JOINTS
Surfacers removing ridges at transverse joints in concrete pavement on New York state highway.

Six Uses of Power Tools for Common Manual Operations

DIGGING A SERVICE CUT
Electric service cut being made with pavement chisel and clay digger on Chicago street.

REMOVING FORM MARKS
Surfacers grinding down form marks on piers of Arthur Kill bridge from Elizabeth, N. J., to Staten Island.

CUTTING OFF SHEETING
Cutting out timber sheeting backed by fill on dock work at Brooklyn, N. Y.

DRIVING SHEETING
Driving wood sheeting for a braced trench for sewer under construction at Cincinnati, Ohio.

BREAKING UP PAVEMENT

equal the efforts of two shovelers and four hand rammers. A crew of eight shovelers and four pneumatic tamper operators works at a cost of $8.08 per hour, including overhead and operating costs, on a 5½x5 portable compressor, as compared with a cost of $12 per hour for doing the same amount of work by hand methods.

On average backfill tamping work, records indicate that a workman can do ten times as much with a pneumatic rammer as by hand. The tamping tool hits 600 blows per minute, with every blow of uniform power and with undiminished power throughout the day. It tamps between and underneath pipes much more thoroughly than can be done with manually operated tools. More dirt is put back into the excavation, reducing the amount to be hauled away. The subgrade is tamped to a hardness that permits the immediate laying of pavement without danger of subsequent settlement.

By changing types of steels, paving breakers are readily convertible to excavating service in various kinds of ground. They also have many special uses other than breaking up material. Instead of tearing up sidewalks by trenching, many public utility companies install service pipes by driving them through the ground from street excavations into cellars, basements, etc. Paving breakers are also sometimes used to drive a steel rod of small diameter to test ground to be trenched. For such service a tower is mounted on a trailer to gain the necessary height for starting. One company reports having successfully tested ground to a depth of 19 ft. along the line of a proposed storm-sewer trench. Three men with this equipment accomplished in one day work equivalent to the efforts of six men in six days by hand.

Power diggers speed up any kind of excavation work that requires the picking of dirt, and they are particularly effective in clay, frozen ground, mica schist, etc., where trenching machines cannot work. They are employed with success on trench work, tunneling, caisson sinking and foundation excavations. Comparative records show that under average conditions one man with a pneumatic digger loosens as much dirt as five men working with ordinary hand picks.

It requires fourteen men with hand tools to dig a trench 100 ft. long, 5 ft. deep and 2 ft. wide in one day. The cost, at $5 wage per man, is $70, or 7c. per cubic foot. The same work can be done by two men with air picks and six shovelers at a total labor cost of $40. Adding a compressor charge of $12, the over-all cost of $52 represents a saving of $18, or 1.8c. per cubic foot. The saving per hour is $2.25. A public utility company that uses fourteen pneumatic trench-digging outfits finds that ten men working eight hours a day with hand picks will loosen 65 cu.yd. of clay per day and that five men with pneumatic picks working seven hours a day will loosen 157 cu.yd.

On tunnel driving through clay a man can handpick from 4 to 6 cu.yd. in eight hours, while with a pneumatic pick he can loosen from 8½ to 11 cu.yd.

For calking pipe, pneumatic hammers are approximately twice as fast as hand methods, the advantage being particularly evident where lead wool is the calking material. Air-calked joints are tighter and more uniform than those placed by hand, and in many cities where service conditions are severe they are the only kind that stand up satisfactorily.

Building Construction

Portable compressors and air tools play a prominent part in building operations and have speeded up this class of work perceptibly. Where old structures are to be removed, pneumatic picks and paving breakers are from two to ten times as efficient as hand methods in demolition of brick or concrete walls. Comparative costs kept by one contractor who wrecked a brick structure showed a saving by the air method of $1.06 for every 1,000 bricks removed.

For removing old foundation walls and for excavation work in soft rock, hardpan, frozen ground, etc., contractors estimate that each air tool does the work of from four to six men with handpicks and bars. On hard rock excavation, air-driven rock drills are universally recognized as superior to hand methods and are extensively employed on such work. In New York City, where most excavation work calls for rock removal and many operations are entirely in rock, some contractors' outfits include 50 or more hand-held drills and fleets of from three to six portable compressors to operate them.

The use of portable compressors to furnish air for operating riveting hammers in building construction work is increasing rapidly. These units can be elevated as erection proceeds and kept close to the points of work. This eliminates long air lines and facilitates signaling for starting and stopping.

The pneumatic piledriver is designed for use on wood piling or sheetpiling of short length. Its driving speed

TAMPING RAILWAY TIES

varies from 2 ft. per minute in hard clay or shale to 9 ft. per minute in sand or gravel. It will do the work of from six to twelve men, depending upon conditions. The pneumatic method conserves piling by reducing brooming.

A portable circular saw will equal the efforts of five hand sawyers and can be easily used in many places where hand sawing would be very awkward and laborious. A link saw driven by an air motor is used on heavy work. Among its advantages is its ability to work under water, making it suitable for harbor work. Records of service indicate that it is from three to seven times faster than hand sawing.

Painting with air possesses the advantge of quicker work and better application of the paint. This last point is important, since it means superior protection from corrosion of the surface painted. Air-driven paint penetrates cracks and joints which cannot be reached by hand brushing. Paint can be satisfactorily sprayed on rough surfaces which are ruinous to hand brushes. The time required for spraying is from one-third to one-twentieth that for hand painting, depending upon the nature of the work. Because of the uniformity of application and the lodgment of a greater amount of paint, one coat of painting by air is frequently found equal in quality to two coats by brush.

Many Special Applications

In the foregoing discussion little or nothing has been said about a wide group of pneumatic tools that have innumerable uses in the construction industry. Such operations as sandblasting and riveting are so generally known to be best accomplished by pneumatic methods as to call for only mention. Nothing has been said of such tools as wire brushes, concrete surfacers, woodborers, scaling tools, chippers, reamers, grinders, pipe-tapping machines, etc. There has been no mention of rock-drilling, guniting, grout injection and pneumatic concrete placing.

One entire field—that of railroad tracklaying and maintenance—has not been touched upon, although it is an important one for pneumatic tools. Using air supplied by wheel-mounted, self-propelled compressors ranging in capacities up to those that will operate twelve tie tampers simultaneously, essentially all operations incidental to preparing the roadbed and laying the rails are performed by specially developed air-driven tools. Among the principal tasks these tools perform are: tie tamping, spike pulling, spike driving, rail bonding, rail bolting, rail drilling, rail sawing, boring ties for screw spikes.

BACKFILLING AND TAMPING

WIRE-BRUSHING PIPE END

Future Development

Since tools and machines have already largely supplanted strictly manual operations, it follows that the major trend of future development will be to improve the appliances now in use. Additional tools will be brought forth as the need for them arises, but types now in service will be adapted to the performance of more operations.

Improvement of pneumatic equipment will probably follow two principal lines: increasing the efficiency of the equipment, and making the equipment easier to operate. The two are closely related, since any change that reduces the fatigue of the man operating a tool adds very positively to the efficiency of that tool. The rapid progress being made in metallurgy insures lighter though more rugged and more durable tools in the future. As the reception of a tool on the job depends very largely upon the ease and facility with which it can be handled, manufacturers will obviously endeavor to produce equipment that will operate with a minimum of human effort.

At present considerable experimentation is being done with high-pressure rock drills, and the success that has been attained indicates that the time is approaching when mounted drills will use approximately double the present 70 to 90 lb. pressure. To eliminate the factor of human variation that slows up drilling speed and induces breakage by failure to keep the bit constantly against the drilling surface in the hole, the latest drills are fitted with a small air motor that insures constant and even feeding. Because this human factor is necessarily present, high pressures cannot be applied to hand-held drills, paving breakers, etc.

A Summing Up

In general air is particularly adapted to driving percussion tools such as rock drills, paving breakers, riveting hammers, calking hammers, tampers and the like and is almost universally used to operate such equipment. It also successfully drives, through air motors, a wide variety of other tools such as hoists, saws, drills, wire brushes, grinders and surfacers.

A plain narration of uses and savings has seemed the best way of driving home the fact that equipment development has been as inclusive of hand tools as of larger machine operations. To the skill of the workman's fingers in directing tools, power tools have given strength and quickness and endurance beyond all possibilities of human muscles.

Economics of Diesel-Powered Construction Equipment

Diesel Applications to Power Shovels, Locomotives, Dredges and Crushers—Remedies for Deficiencies in Torque—Fuel Saving Is Chief Advantage—Engine Principle and Internal Structure Explained

By L. H. Morrison
Associate Editor, Power, New York City

Self-contained power units for construction equipment have undergone a great change in a few years. Within a decade the internal combustion engine has become superior not only for small machines like concrete mixers and contractors' pumps but for the heaviest power shovels and dredges. Its fuel economy and ease of servicing have risen superior to its considerable disadvantage in starting and uptake torque even to such a degree that there is economy in combination units in which electricity and compressed air are the media for applying the power. It is its fuel economy that has put the diesel engine, capable of utilizing a cheap oil instead of gasoline, in the march toward a future high place as a prime mover for construction equipment. This article is an estimate of the diesel engine as compared with steam engines and gasoline engines. —Editor.

THERE is a pronounced trend in the power engineering of construction equipment, particularly of the heavier kinds as power shovels, dredges, rock crushers and locomotives, toward diesel engines. This prime mover is taking the place of the gasoline engine as that power unit has been taking the place of the steam engine. So much for the facts. The problem of the contractor in the market for equipment is to decide if the change to the oil engine is merely an illogical temporary shelving of the gasoline and the steam engine or if the diesel has the greater economic advantages. The following comparison is made on the basis of investment cost, running costs and operating characteristics.

Power Shovels

The modern power shovel is a variously powered tool. It is sometimes properly a steam shovel, as fifteen or twenty years ago it was in every instance. But more commonly it is gasoline-engine powered, and it is just beginning to be largely diesel-engine powered. In other instances its internal-combustion prime mover generates electric current or compressed air by which the shovel mechanism is actuated. All these types are considered.

Investment Cost—The steam shovel costs much less than a diesel or even a gas-driven machine. Usually the diesel shovel will cost about $30 per engine horsepower more than a steam machine and about $20 per horsepower more than a gasoline shovel of equal yard capacity.

Fuel Consumption—Take, for example, a shovel equipped with a 50-hp. steam engine and boiler: The boiler, on account of its short stack, short tubes, small firebox and indifferent firing, is less efficient than a house furnace. Seldom is more than 40 per cent of the heat in the fuel used to generate steam. The efficiency of the engine is very low; a steam consumption of 75 lb. per horsepower-hour is considered average practice. These factors bring the coal consumed per horsepower per hour up to approximately 15 lb.

Assuming that the shovel works at an average rate of half-load, the fuel consumption per hour will be 375 lb. A corresponding gasoline shovel would be rated at 75 hp., the increased horsepower being necessary on account of the absence of overload capacity in the gasoline engine. If the average load on the shovel be one-half capacity, the engine uses approximately 6 gal. of gasoline per hour. The diesel handling the same load under similar operating conditions will consume approximately 2.5 gal. of 5c. oil per hour.

Lubrication and Upkeep Costs—The lubricating oil consumption is in favor of the steam engine. The diesel will use ½ gal. per day, and the gasoline engine 1 gal., while the steam engine's lubrication should not exceed ¼ gal. Compared with the gasoline engine, the cost of repairs favors the diesel, for the latter is better built.

Application—The application of the diesel engine to shovels is not different from the application of the gasoline engine. The engine is mounted in the position that would ordinarily be occupied by the boiler of a steam machine. A set of machine-cut gears constitutes the power take-off from the engine shaft to the several clutches serving the cable drums. Contrary to a common belief, there is no disadvantage in a fairly heavy

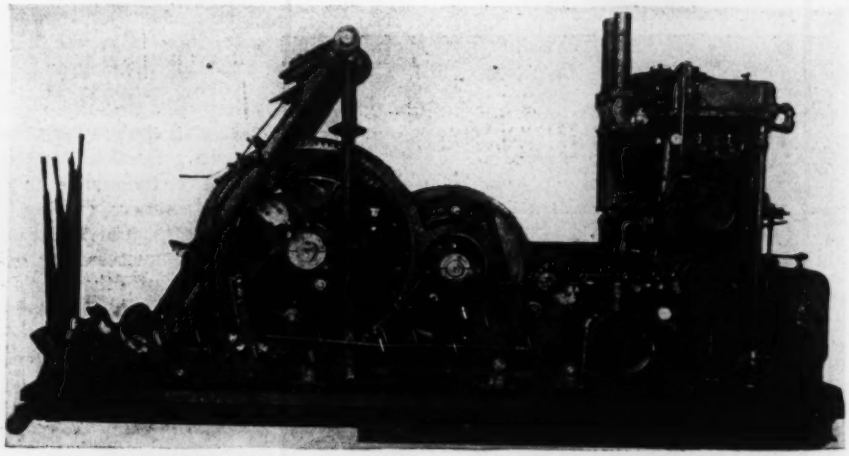

FIG. 1—GEAR-CONNECTED DIESEL POWER UNIT FOR POWER SHOVELS

engine, for the machine must in all events be weighted to counterbalance the thrust of the dipper arm. A typical assembly is shown in Fig. 1. Usually the engine and drums are mounted on a steel casting which is a part of the revolving table of the excavator. The gears used vary from plain spur to double helical.

When the shovel is in operation the engine is run continuously, the governor controlling the fuel charge according to the load on the shovel. While a clutch on the engine shaft adds to the cost, it is highly desirable, because the engine need not be stopped when the drum clutches require tightening.

Torque Characteristics—The operating advantage is with the steam shovel in several respects. When, for example, the dipper comes up against a boulder, the steam engine, ungoverned as it is in modern machines, exerts a torque based on full boiler pressure acting on

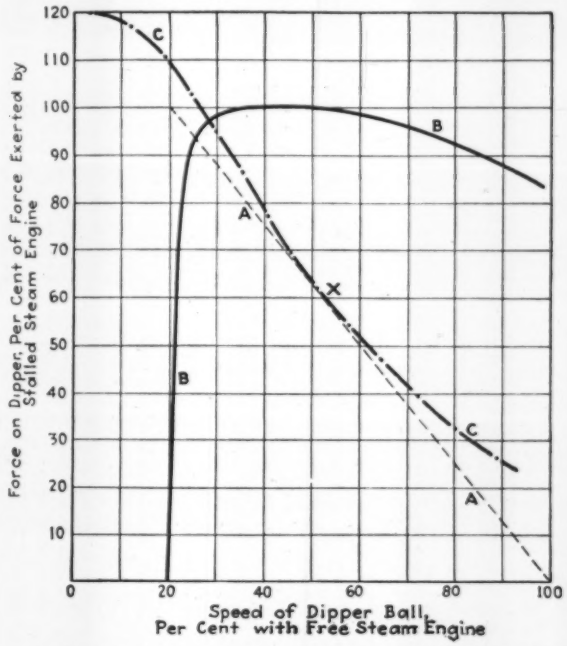

FIG. 2—GRAPH COMPARING TORQUE OF VARIOUS POWER SHOVEL POWER UNITS

the area of the piston. As the resistance decreases the dipper rises up through the dirt bank with increasing speed. The greatest torque and consequently the greatest force on the dipper bail is exerted at the minimum engine speed. This is illustrated in Fig. 2, where the curve *A* shows the variations of the bail speed and force on the dipper in the case of an ungoverned steam engine. The normal torque at normal boiler power at which the engine is rated, say 50 hp., is at the point *X*.

The diesel engine, on the other hand, has an almost constant torque from normal speed down to about 20 per cent of normal, at which latter point most engines now built will drop the load. The force exerted on the dipper bail at various speeds in per cent of that of the steam engine is indicated by curve *B*, Fig. 2. The diesel is somewhat superior to the gasoline unit in the matter of torque. When a gasoline engine has its speed reduced to 50 per cent normal, its torque drops off so that the bail pull decreases, and as the speed decreases the tendency to stop is marked.

To avoid the difficulties introduced by the diesel's

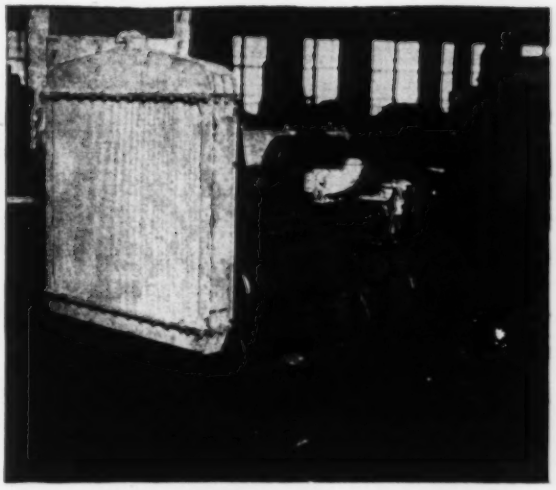

FIG. 3—DIESEL-ELECTRIC POWER UNIT

torque characteristics, dependence must be placed on the clutch of geared machines, permitting it to slip when the dipper strikes the bank. However, the torque remains as before, and consequently the diesel should be of a larger capacity than is required for the steam engine, but can be slightly lower in rating than a gasoline engine.

Combination Power Drives—To avoid the unfavorable torque characteristics of the diesel gear-drive, the diesel-electric plan has been adopted by a few shovel builders, especially for excavators of large capacity. In this design the engine is coupled to a direct-current generator having an armature winding that gives a droop in the voltage-ampere characteristic.

One motor drives the swing, a second the hoist and a third the dipper crowd. When the dipper encounters a resistance, the engineer by rheostat control increases the current flow to this motor and the special generator winding automatically reduces the voltage so that the power output of the generator is approximately constant, although the motor torque is raised to a high value. This action is illustrated by curve *C* in Fig. 2. It will be seen that its action closely parallels that of the steam engine. An engine-generator unit of this type is shown by Fig. 3.

Still another hook-up experimented with in connection with gas engines, but offering greater possibilities with a diesel, is the combination of the engine, which is geared

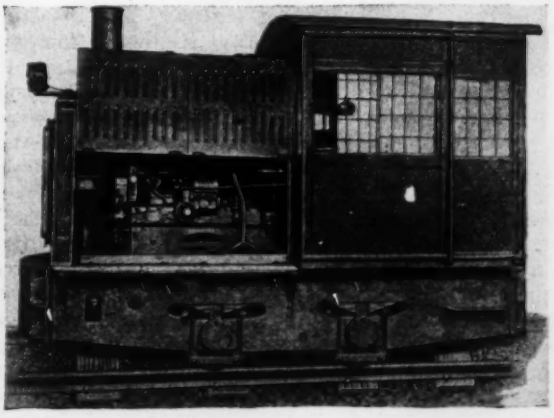

FIG. 4—DIESEL LOCOMOTIVE WITH GEAR SHIFT

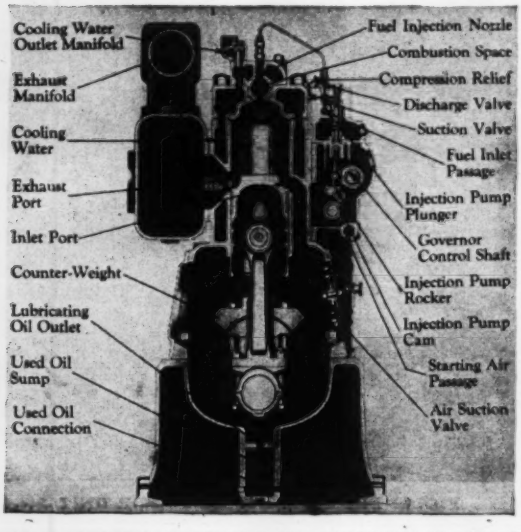

FIG. 5—WORKING PARTS AND OPERATING CYCLE OF TWO-STROKE DIESEL

to the swing and boom, with an air compressor. The compressor supplies air to the usual steam crowding engine, which is arranged to use air instead of steam. Heating the air by the exhaust from the diesel raises its temperature to about 400 deg. F. and gives an efficiency that is fairly high. This arrangement costs more than the geared unit but less than the diesel-electric. It contains latent possibilities that will be made available in the near future.

Diesel Locomotives

Of all diesel applications the most revolutionary is the locomotive. Locomotives used in construction were until a few years ago exclusively steam. Then the development of the heavy-duty gasoline engine gave an impetus to the gasoline locomotive, for the operating costs were much below those of a steam unit. Upon the successful development of the high-speed diesel, locomotive builders were quick to see the advantages of low fuel and maintenance costs. While the cost is about $30 per horsepower above the cost of a gasoline locomotive, the operating savings justify the increased investment.

To a locomotive user, the high starting torque of the steam machines is of course attractive, and in this respect the straight diesel or gas locomotive suffers somewhat. Nevertheless the operator, like the truck driver, soon becomes an adept at starting in low gear and obtaining the necessary drawbar pull by letting the clutch slip until the train gains acceleration. Changing from low through intermediate to high gear is as easy as with an automobile. A locomotive with a gear shift is shown in Fig. 4, the engine being a two-stroke-cycle high-speed diesel.

To escape the limitation of drawbar pull inherent in the geared locomotive, the diesel-electric design has been introduced. Here the engine drives a direct-current generator supplying current to the motors mounted on the wheel axles. The motor and generator windings are such that when starting a train the current amperage of the motor is high, giving a high drawbar pull, but the voltage upon which the motor speed depends is low. As the load on the engine is the product of the volts and amperes supplied the motor, it is obvious that the engine can operate at a constant load and speed regardless of the train speed. The cost of diesel-electric transmission is high, which has limited its application to locomotives of 300 hp. and over. When production methods are improved, the diesel-electric design will be obtainable in capacities as low as 50 hp.

Dredges and Crushers

Dredges and rock crushers are two types of machinery that should be exclusively dieselized. The dredge requires a large power plant, and neither steam nor gasoline engines can compete with the diesel. In many installations the dredge pump is direct-connected to the engine. To avoid damage in case a tree root jams the pump, a magnetic clutch should be interposed between the pump and engine. Some of these plants have the pump and the conveyor motor driven by current from a diesel generator set. Such plants obtain their power for 2c. per kilowatt or less, including all operating and capital charges. A distinct advantage is the ability of the dredge to maneuver without having a licensed steamboat engineer. As there are no stand-by expenses for coal, the engine costs little to maintain when idle. The largest U. S. government dredges are equipped with diesels, and hundreds of small sand dredges have found it the solution of the demand for cheap power.

For rock-crushing plants no form of power can meet the diesel records. The crusher must be moved at times to a new location. A steam plant can be moved only

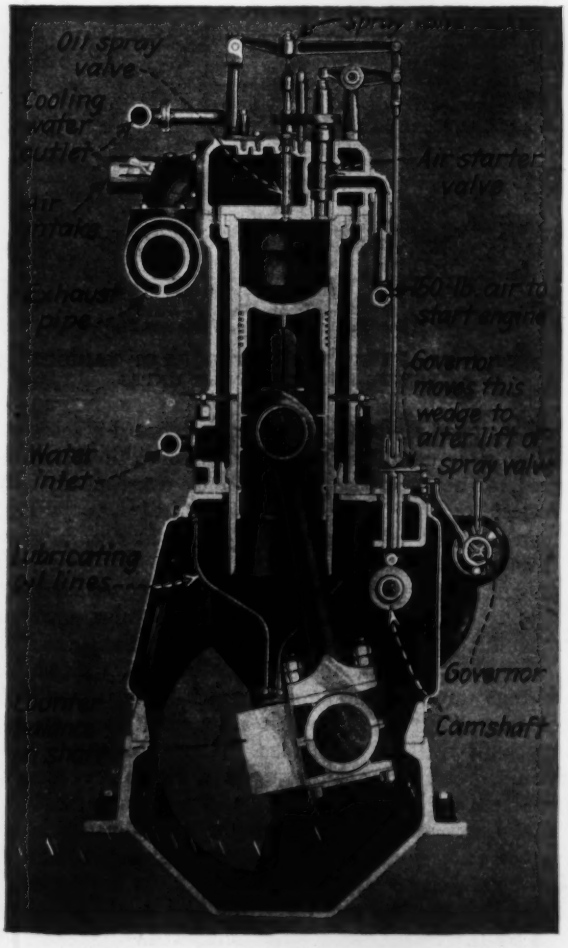

FIG. 6—WORKING PARTS AND OPERATING CYCLE OF FOUR-STROKE DIESEL

at a sacrifice; the diesel can be lifted from its foundation and moved to a new site at a small cost, about $3 per horsepower for labor of erection and about $4 per horsepower for the new foundation. Usually the power plant is located a few hundred feet away from the rock crusher and supplies electrical energy to individual motors on the crushers, elevators and screws.

Small diesels have been applied to concrete mixers; the savings, however, are not considerable except in the large central mixing plants. Portable mixers using a 6- to 10-hp. find the gasoline engine more suitable.

Diesel Principle and Mechanism

In its main structural features the diesel engine follows the general lines of a heavy-duty gasoline engine. As with the latter, power is generated in the working cylinder by the combustion of a mixture of fuel and air. There is, however, a decidedly marked difference in the method of fuel introduction. The gasoline engine must have its fuel vaporized or carbureted in a carburetor, where it mixes with the air and is drawn into the engine cylinder during the suction stroke of the piston. As a mixture of gas and air will explode automatically when a certain temperature is reached, the gasoline engine must not have a compression pressure so high as to cause the temperature, which depends upon the compression pressure, to reach 600 deg. F., consequently a compression pressure of less than 100 lb. per sq.in. is usual. Ignition is by a sparkplug.

Nothing but fresh air is drawn into the diesel's cylinder, and this air is compressed by the upward travel of the piston until it has a pressure of around 500 lb. per sq.in., which causes the air to get red hot, the temperature being as high as 1,000 deg. F. This temperature is so high that when the oil is introduced it is ignited automatically without the need of a sparkplug. As the efficiency of an engine depends upon the compression pressure reached, it is easy to see that the diesel will use much less fuel than a gas engine.

The oil is injected either by high-pressure air or by the direct action of a pump. All of the diesels now used on shovels use pump injection, or "solid injection," as it is known. While a number of engines on the market are suitable for contractors' work, only a few builders have as yet arranged their engines specifically for this work.

In Fig. 5 is shown a two-stroke-cycle diesel. The simplicity of the unit may be seen from the cross-section. Air is first drawn into the crankcase, where the downward movement of the power piston compresses the air to about 4-lb. pressure. When the piston reaches the lower end of its travel it uncovers the exhaust ports to permit the burned gases to blow out. At the same time the scavenging ports are uncovered, and the air from the crankcase rushes in to blow out the burned gases and charge the cylinder with a fresh supply of air. At the upper end of the piston travel the fuel is forced through the nozzle by a fuel-pump plunger, one being provided for each engine cylinder.

An engine operating on the four-stroke-cycle principle is shown by Fig. 6. Fuel is pumped into a manifold or "rail" by three pumps and a pressure-relief valve holds the pressure at around 4,000 lb. per sq.in. Each cylinder head has a fuel valve equipped with a needle which is opened at the proper time by a cam-operated push rod and lever. The oil then blows into the cylinder under the 4,000-lb. pressure existing in the manifold.

Other makes of diesel engine of both two- and four-stroke cycle types vary in various particulars, but all operate on the same principle and have the same applications and advantages as power units for construction equipment.

Credit Reform Demanded in Time-Payment Sales

Testimony of False Credit Evils Offered by Contractors and Public-Works Engineers—Co-operation in Sane Credit Schedules Being Sought by Organized Contracting

By S. M. Williams

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Overproduction in equipment has so intensified competition that in recent years great laxity has developed in extending credit to contractors. The result has been virtual disruption of common-sense business credit practices and the induction into contracting of much irresponsible bidding. A remedy is necessary. This article indicates the conditions that exist and outlines efforts by organized contracting to bring about reform

NOT MANY years ago manufacturers of construction equipment would have looked with much disfavor on one of their number who predicted as probable the sales and credit policies of the present. In those days manufacturers would have denied any possibility that they would transcend their own functions and take on those of the legitimate banker. Indeed, one may well wonder at the change. *Today manufacturers and distributors by loose and false credit policies are disregarding every principle of fair trade practice.*

In 1925 a former president of the National Association of Equipment Distributors stated, in an address before the Illinois Association of Highway and Municipal Contractors:

> Unfortunately, many men selling equipment and machinery sell terms and not machinery. This is due to the fact that in many cases they don't know their product, don't know its application and don't know their competitor's product, and as a result when they do business with a man that does know, they fall back on one of two recourses. The first is to ingratiate themselves with the prospective buyer by being jolly good fellows and throwing a party or two; the other is to give him outlandish credit terms.

The unethical practices of 1925 by many manufacturers not only have continued but have increased so that there has been injected into the construction industry a large element of irresponsibility and inexperi-

ence which is worrying the public official charged with the responsibility in the award of construction contracts and is costing the public vast sums of money annually.

During 1928 in one individual district of one state on highway work alone there were nine defaults or failures. This means delay in completion of contracts and loss to the public in the use of the improvement. These losses have frequently been known to be more than the original estimated cost of the improvement. A prominent public official has said:

> It has been the custom for the surety bond companies, the equipment and material manufacturers, the banks and the contractors themselves to cry aloud in anguish over the lack of vision of the public official in awarding contracts to irresponsibles. At the same time each of these agencies has perpetuated practices and policies which have made the path of the novice, the crook and the plunger one of roses, and have forced the public official to stand the gaff of public criticism and even suspicion of his integrity if he were to carry out the dictates of his unbiased judgment in the elimination of irresponsible bidders.

Another prominent public official recently said: "The stabilization of credit in the construction industry is essential if public officials are to be relieved of existing conditions facing them in the award of construction contracts."

Not only have equipment manufacturers ignored the interest of the construction industry but they have deliberately become a part of the irresponsible element by furnishing credit for capital without any regard to the experience of the individual they were injecting into the industry. In this practice manufacturers of construction equipment have become competitors of the responsible and experienced contractors to whom they have sold or hope to sell equipment.

These practices in sale of equipment are acknowledged by many manufacturers and distributors to be unethical and unsound. Manufacturers are blaming the distributors; distributors are blaming the manufacturers. Both are blaming the contractors, and contractors are blaming the manufacturers and distributors. Personally I agree with all of them, because each has been responsible in encouraging the present credit practices.

Motor Truck Situation Is Bad

Motor truck manufacturers and distributors particularly have been responsible for injecting into the industry the irresponsible hauler, who has become a serious menace to the responsible contractor. The latter realizes that if the subcontract hauler on a road contract is to be satisfactory to the general contractor his profit must be more than sufficient to cover overhead, interest, depreciation, maintenance and living expenses.

In all sections of the country the motor truck industry has been feeding into the construction industry the irresponsible and inexperienced hauler as rapidly as it could induce the individual to part with what little money he had and to enter into note obligations secured by some sort of sale security for the balance. Frequently—and this should be said with emphasis, because in many, many cases the note obligations were for the full amount, as no cash was received—the individual was allured with the alleged wonderful possibilities in road hauling as a profitable business. In many cases trucks have been sold upon the basis of securing a hauling contract for the hauler. The trucks were sold, the hauling contract was secured, and the haulers with new trucks were deliberately placed on the work at a price which the salesman knew or should have known would not earn for the hauler sufficient money for him to meet his note obligations.

In Chicago the motor truck industry recognized the conditions and early in 1927 organized the distributors into an association, with the result that a large number of motor vehicles were taken out of the hands of men who were attempting to earn an honest living upon the basis of inadequate hauling revenue. The following figures show the repossessions of motor trucks by members of the Chicago association during only a part of 1927:

> In all, 536 trucks were repossessed, of which 358 had been hauling in connection with building or engineering construction. An analysis of 323 of the 536 trucks repossessed showed that 103 had been sold with no cash payments, 104 with cash payments of less than 10 per cent, 82 with cash payments between 10 to 20 per cent and 34 with cash payments over 20 per cent. The total amount of sales covering the 423 trucks was $1,143,704, upon which credit was extended for $1,048,596, upon which $380,944, or 36.3 per cent, was charged off in bad debts.

When the motor truck industry awakens to its obligation to the construction industry there will be an honest presentation of construction hauling costs so that both the general contractor and the subcontract hauler may approach the subject in an intelligent manner.

But the Truck Trade Is Not Exceptional—Consider Shovels!

In the shovel industry sound business practice involving sane credit policies is a thing of bygone days. Conditions not long ago reached a state that certain manufacturers were delivering to contractors shovels selling for $17,000 to $18,000 plus freight charges of $1,500 *with no cash payment for even the freight,* and with time payments beginning six months or more after date of shipment and running two years and longer. In other lines of equipment false credit practices were well in line with those of motor truck and shovel manufacturers. The sale of terms, not product, had become common.

Responsibility for Reform

The remedy for the evils in connection with the sale of construction equipment is entirely in the hands of the responsible and experienced element in the construction industry. The equipment industry cannot prosper if its entire business is confined to the irresponsible element. So long, then, as responsible and experienced contractors are willing to purchase equipment from those whose greed for volume of business exceeds their interest in the welfare of the construction industry, they are encouraging a continuance of the unethical practices of the past.

The effort of the Associated General Contractors during the last year for a discontinuance of past practices has recognized that until responsible and experienced contractors have sufficient interest in their industry to protect it by setting an example for sound business ethics they are not entitled to demand it from others. For more than a year this association has purposely endeavored to awaken in minds of the contractor, the manufacturer and the distributor a definite realization of obligation to the construction industry.

To date 50 manufacturers of construction equipment have individually assured the construction industry, through the A.G.C. as an intermediary, that the individual credit policies of their companies would be at least as conservative as the terms recommended by the 1928 conference of the manufacturers and distributors. The campaign during 1928, which has awakened a general realization of obligation, will be continued until the present uneconomic conditions in the construction industry are eliminated and if possible the construction industry commands the same recognition from the public as is accorded to other legitimate industries.

Building a Concrete Road in 1909

The Equipment Factor in Estimating Costs

Equipment Factor in Cost Estimating Considered Under Heads of Depreciation and Direct Costs—A Summary Estimate Shows Equipment Charges Exceeded Only by the Cost of Materials

By A. H. Hunter

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In a dozen years equipment has become a dominant factor in construction and labor has become a minor factor. This has brought a new set-up relatively, in the character of the costs which have to be considered in making estimates and bids. Plant investment, depreciation, rental, amortization, obsolescence, repairs and upkeep are charges that have to be considered and appraised. This article states the new situation as contrasted with the older. It indicates by general percentages the value of the equipment factor as compared with other factors as labor, materials, overhead, etc. It indicates how to handle equipment charges so as to appraise them truthfully in bidding. It considers production as an influence in evaluating equipment charges. It lays down general principles of equipment accounting. In discussing the problems which this mechanization of construction has raised simplicity has been sought by considering highway construction alone.

Difficulties of Logical Depreciation

Depreciation is an attempt by the contractor to evaluate in dollars and cents the effects of time and service upon the physical properties of his equipment. Nature of work, rigidity of construction, timely maintenance, adequate storage and the personal attitude of the contractor himself have much to do with the rate at which the physical properties of equipment are impaired. Engineers may change specifications or find it necessary to work on diminished programs. The development of new equipment or unforeseen industrial advances may disrupt the most complete calculations on depreciation.

A special committee of the Associated General Contractors, working for two years with the U. S. Bureau of Internal Revenue, has reported five methods of equipment depreciation. In introducing the report, comment is made that no one method of handling depreciation is suitable to the accounting needs of all companies. Further, no grounds seem to exist for comparing depreciation of equipment in the manufacturing and in the construction industries. Five methods follow:

Straight Line—The useful life of each piece of equipment is estimated in years and the fixed annual percentage of initial cost is charged off each year. This charge-off is made whether equipment is idle or in use. Each item may be depreciated or groups of items having the same useful life may be depreciated as a class under the proper rate.

Unit of Work—The useful life of each piece of equipment is estimated in units of work, such as square yards, cubic yards, tons, hours, days and weeks of operation or any other units of production. The depreciation is written off each year in proportion to the number of units delivered. No depreciation is taken when equipment is idle.

Composite Rate—This method consists in the use of the straight-line or unit-of-work methods for computing the annual depreciation and dividing this by the total investment in equipment, thereby securing a weighted average rate expressed in percentage. This rate is to apply each year to the equipment as a whole unless the outfit is altered by changed type or number of constituent items.

Job Charge-Off—This method provides for charging depreciation of specific machines against the particular job for which they were purchased. The amount charged is the difference between the original cost of the equipment to the contractor and its actual or estimated salable value at the end of the job.

This method is applicable to special equipment for which there is no further use after the project is completed. It is used by companies that make a practice of buying equipment for each job and disposing of the used machinery upon completion of the project. It may be used initially for all equipment purchased specifically

for any job. If the owner later decides to retain his special equipment for use on some future contract he may substitute either the straight-line or unit-of-work method as a basis for writing off the remainder of the undepreciated cost.

Appraisal of Useful Life—Under this method the unexhausted useful life of each item of equipment is periodically estimated by competent appraisers and a proper percentage of the value is charged off as depreciation. The factor of market value is not considered, and the appraisal concerns only the percentage of useful life consumed and that remaining in terms of the original cost. Obviously the total depreciation finally taken cannot be more than 100 per cent of that cost.

It has been the aim of those engaged in this work to provide some degree of flexibility, as obviously equipment operates under variable conditions and it is recognized that gradual loss of value may take place in the form of obsolescence. There are other losses sudden in nature which cannot be predicted but which must be absorbed when they are known to have occurred.

Time is more than ever before the essence of a contract. The pressing need of improvements shortens the time limit until there is practically no hope of securing contracts that extend beyond one season. After this one season all constructors are at the mercy of the prevailing market prices. Even periods of enforced idleness cannot be avoided. This suggests that reasonable leeway must be provided in all problems of equipment charges.

No man can predict the volume of available work sufficiently far in advance to cover the life of modern machinery. In general most contractors are too optimistic of the future. They fail to recognize that public-work programs are dependent upon legislation and adequate appropriations. Court actions with injunctions have frequently delayed large volumes of public improvements.

Production and capacity are not synonymous, but experience indicates that some have confused these terms to the point of basing their volume of work per season upon capacity rather than upon the production actually to be secured. The Illinois Division of Highways has construction records covering state highway programs during the period of the state bond issues. A tabulation of the mileage per year, the number of mixers engaged and the average miles produced per mixer is given in Table I.

TABLE I—PRODUCTION CHART—ILLINOIS DIVISION OF HIGHWAYS

Year	Miles Built	No. Mixers	Miles Per Mixer
1920	340.6	126	2.70
1921	413.9	102	4.06
1922	740.8	213	3.48
1293	1,085.0	199	5.45
1924	1,229.5	183	6.72
1925	906.4	130	6.97
1926	463.7	104	4.46
1927	668.4	149	4.50
1928	1,304.7	203	6.43

PAVING MIXER OF 1929 DISCHARGING A YARD BATCH

A casual glance at these figures will show that the miles of 18-ft. concrete highways completed did not exceed 7 miles per mixer in the best seasons. No doubt some of these mixers built in addition a fair mileage of paving in municipalities or adjacent states. We very much doubt that the productive average exceeded 8 miles per mixer even in the best years. This is quite different from the 15 to 18 miles seasonal capacity of most of this equipment.

In recent months there have been few innovations, but the perfecting of time- and labor-saving devices continues. A few weeks ago the writer was permitted to scan some construction records of the Illinois

TABLE II—EQUIPMENT TREND OF PAVING MIXERS IN 1927-1928

Type	1927 No.	1927 Per Cent	1928 No.	1928 Per Cent
Five-bag	58	39.0	44	21.7
Six-bag	44	29.5	92	45.3
All others	47	31.5	67	33.0
Total	149	100.0	203	100.0

Division of Highways. The change in pavement mixer sizes that had occurred in one season was astonishing. This advance in mechanical equipment is expressed in Table II.

The volume of work produced in 1928 was almost double that of 1927, yet the five-bag mixers had declined in appreciable numbers and at an astonishing rate when expressed in percentage. This is concrete evidence that the five-bag mixer is being discarded for larger and better equipment. It would not be extreme to think of it as obsolete by 1930.

Direct Equipment Costs

Besides depreciation, mechanization has brought certain direct expenses that have to be considered.

Repairs and Fuel—Repairs and upkeep of equipment bear some relation to its serviceability. Old dilapidated units mean excessive charges. In contrast new and suitable equipment means lower charges with lower production costs over the job as a whole. Loss of time occasioned by breakdowns of machinery incurs added labor charges that may even endanger the profits of the job. Whether old or new, the equipment must be in such condition as properly to render the service for which it was intended.

It has been the privilege of the writer to examine the records of millions of dollars of construction costs. Seemingly there should be some relation in work with the same average hauls, general type of equipment, etc. Apparently every contractor has his own personal equation, and it is much the same as the care and attention that men give to their private cars. One may be carefully washed, polished, greased and stored; the other totally without attention except for necessary repairs.

The best records of annual repairs express the amount as a fixed sum per unit of work or as a percentage of the first cost of equipment. It matters little which method is employed. In most of the expense records examined no particular arrangement had been worked out. The expenses had simply been preserved with no thought of establishing a basic item for estimating purposes.

The items of fuel, oil, gas, grease, etc., necessary for the operation of equipment have not received much consideration either in estimates or in cost records. Undoubtedly every one comprehends what they mean, but we have not had sufficient years of experience to establish this expenditure authoritatively. The change of motive power from steam to gasoline is hardly over; a few steam cranes and mixers will still be found. Nor can gasoline motors be considered as permanent. The diesel engine is already supplanting the gasoline motor before steam has entirely vanished.

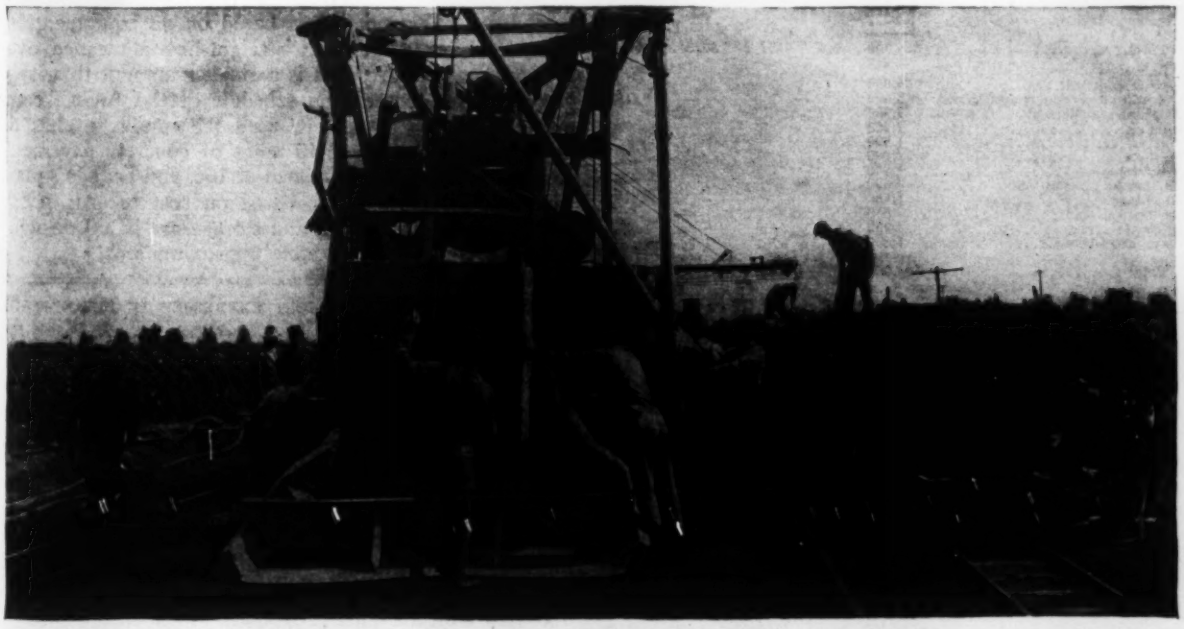
In the writer's revised estimating work he consulted the records of experienced contractors and is presenting here full costs from several miles of concrete paving work. One would expect some variation in figures due to varying lengths of haul and type of transportation equipment. Apparently working conditions and the nature of the hauling road have more to do with fuel expenditures than anything else. In other words, experienced contractors will profit most from their own records, because they know the working conditions.

TABLE III—EQUIPMENT COSTS, REPAIRS AND FUEL

Job	Miles Pavement	Repair Cost	Repairs, Sq.Yd.	Fuel Costs	Fuel Sq.Yd
1	3.57	$3,926.62	$0.103	$1,881.26	$0.050
2	9.95	9,995.19	0.095	4,965.03	0.047
3	4.46	5,218.42	0.111	3,559.72	0.076
4	3.12	1,743.13	0.053	1,135.72	0.076
5	6.97	3,796.42	0.052	3,829.94	0.052
6	6.12	11,496.29	0.178	2,739.52	0.042
7	4.48	6,327.16	0.134	3,020.52	0.064
8	15.88	16,118.00	0.100	10,774.17	0.064
Weighted average for repairs..... 10.1c. per square yard					
Weighted average for fuel..... 5.5c. per square yard					

Table III indicates the expenditure per square yard of pavement for both repairs and fuel, as arranged from records supplied by reliable Illinois contractors. It represents eight complete sections of concrete pavement, or a total of 576,000 sq.yd. Attention is invited to the repairs on Job 6. This unit cost of 17.8c. includes a general overhauling charge or shop repair for trucks used on Jobs 4, 5 and 6. If properly distributed, it would increase the cost of repairs on Jobs 4 and 5, with a corresponding reduction on Job 6.

Freight In and Out—The transportation of equipment



CHARGING 1929 PAVER BY INDUSTRIAL CARS CARRYING BATCH BOXES

from contract to contract necessitates an unavoidable item of construction expense. Fortunate indeed is the man who can progress along the length of a highway on a continuous section. A move is expected at the end of a season, and not infrequently entire construction units must be transported the length or breadth of a state even in mid-season.

How many contractors can approximate the number of railroad cars required or the expense incurred? Not many, it is probable. Truck outfits are conveniently handled on short moves, but cranes, mixers and all heavy machinery must be shipped by rail unless the move is very short. Industrial outfits are still more cumbersome. In brief, equipment must have position before it becomes productive and freight and labor are positive items of expense. Estimate of freight costs should be based upon the number of railroad cars required and the existing freight rates between the points of shipment.

Storage—We like to think that a man's success may be measured by the appearance of his equipment, but it may be otherwise. Even if the contractor is disinclined to provide proper sheds and storage facilities, he must bear in mind that he has an interest in the space the equipment occupies. If the storage yard, although uncovered, is not owned, it must be rented, and this expense should be recognized. In years past many contractors were inclined to enumerate this item of storage as a part of their general overhead. Preferably it should be placed as expense occasioned by equipment.

In the preparation of a bid on construction work, preferably one should be guided by experience rather than by theory or by figures with which he may not be entirely familiar. Every man in the construction industry today had a time in his life when he was obliged to depend upon outside information for estimating purposes. As he grew and continued to develop he should have built up a cost-record system as a basis for his future estimating information. Changes in specifications, types of improvements, and development of equipment make necessary almost continual changes in systems of accounting and cost records. He should bear in mind that records as recent as three or four years may be misleading due to advancement and improved practice. To be of greatest value estimating information must be up to the minute.

In the engineering work of the Illinois Highway and Municipal Contractors Association it became apparent that a study of construction costs was necessary. All items on a project are important enough, but pavement representing from 85 to 90 per cent of the cost of any project is the most vital. In our opinion the most difficult problem was that of equipment. Materials can be accurately determined, labor is a direct cash expenditure and overhead is fairly determinate if one but takes the time to break it up.

It was the aim in preparing an estimate of pavement costs to arrange equipment as the first major item of expense. The general main headings are equipment, materials, labor, overhead, and profit. The estimating data and summary of complete estimate for average conditions are here given.

In the estimated study of costs 10 miles has been chosen as a basis, because it is a conservative figure in that the estimated unit prices for pavement will be lower than are usually found in practice. Labor and materials will not change, but general expenses and depreciation will be much less per unit of pavements than if a 7-mile section were employed, which is approximately the best found in years of large production.

TABLE IV—SUMMARY ESTIMATE OF CONCRETE PAVEMENT

Equipment:	Item Cost	528 Ft./Day Cost Per Sq.Yd.	Per Cent	800 Ft./Day Cost Per Sq.Yd.	Per Cent
Depreciation	$19,500				
Repairs	10,600				
Fuel, gas, oil, grease, etc.	5,300				
Freight, in and out	1,000				
Storage	500				
Total	$36,900	34.9	21.6	34.0	23.0
Materials:					
Cement	.....				
Sand	$17,200				
Gravel	35,000				
Water	200				
Reinforcing steel	7,600				
Calcium chloride	4,000				
Expansion devices	.....				
Total	$64,000	60.6	37.6	60.6	41.1
Labor:					
Superintendence	$4,400				
Unloading and propor. aggregate	3,600				
Handling cement	2,900				
Hauling	3,500				
Water	1,500				
Forms	4,000				
Reinforcing steel	1,500				
Mixing and placing	4,600				
Finishing	1,400				
Curing	800				
Subgrade	4,200				
Moving in and out	1,600				
Total	$34,000	32.2	20.0	21.5	14.6
Overhead:					
General expenses:					
General office	$3,400				
Contractors' drawing account	4,000				
Field office	500				
Plant set-up:					
Property rentals and damages	500				
Switch or trackage	1,500				
Finance:					
Interest	1,000				
Bonds	2,800				
Insurance	3,100				
Contingencies:					
Delays, bad weather, protection against freezing, car shortage, errors, damage suits, loss on materials, camp loss, strikes, etc.	3,000				T
Total	$19,800	18.8	11.7	18.0	12.2
Profit:					
10 per cent	$15,400	14.6	9.1	13.4	9.1
Total estimate	$170,100	$1.611	$100.00	1.475	100.00

Discussion of Estimate Summary

Without attempting details the writer wishes to give some explicit information on the charges made for equipment. Depreciation is based on an equipment investment of $78,000 with straight-line allowance over a four-year period. This is a smaller amount than suggested in the depreciation schedule of the A.G.C. committee. On the basis here used the equipment has an estimated useful life of 40 miles of concrete pavement. Repairs and fuel are estimated at 10c. and 5c. per square yard respectively and are based on cost records previously explained. Freight and storage are based on what are believed to be reasonable approximations.

TABLE V—CONSTRUCTION COST EXPRESSED IN PERCENTAGE

Equipment	20%-25%	Overhead	10%-12%
Materials	35%-40%	Profit	10%-10%
Labor	15%-20%		

In the last two columns of the summary are revised unit prices and percentages that could be expected on a production average of 800 ft. per day. As a matter of fact, this estimated cost represents closely the weighted average price of pavements as actually awarded for the past three seasons and covers a total of some 2,400 miles of improvement.

A tabulation of the main items expressed in percentage may indicate some proportion of expenses. This is shown in Table V.

Practical Advantages of Standardizing
—A Contractor's Summary of 30 Years' Experience

Statement of the Obstacles to and the Benefits of Standardizing on Kinds and Makes of Construction Machines and Tools in General Engineering Contracting

By F. L. Copeland
Vice-President, Bates & Rogers Construction Company, Chicago, Ill.

CONSTRUCTION operations commonly exhibit a miscellaneous selection of machines for the same purpose. There will be, for example, pumps of half a dozen kinds and makes for substantially the same purpose, as many kinds and makes of concrete mixers, and so on through the plant elements. To simplify the problems of purchasing, servicing, operating and cost accounting, contractors having a wide variety of operations in many localities are finding it profitable to give thought to standardizing on makes, sizes and types of equipment. The construction firm for which the writer speaks has followed this practice through all of its nearly 30 years of construction in all parts of the United States and Canada and has found it profitable.

While standardizing equipment by contractors is sound general principle, it must, as in the case of all rules of construction, be employed with intelligence. There are disadvantages as well as advantages in standardizing equipment. There are often definite and controlling limitations to the practice. They all come out of the conditions and the purposes of the construction business. The business of the constructor is to perform a task in time, place and character determined by another at a profit for himself. He is not in business to make records in standardization of equipment. Frequently, then, he must and should throw into the discard his rules for standardization, however firmly he may believe in the practice as a general policy. A few considerations common in actual construction by contract will make the situation clear.

Obstacles to Standardization

Let it be noted first that construction plant is a widely varying assemblage of tools. This is particularly true in the case of general contracting for engineering construction. The plant will include power shovels, locomotives, cars, caterpillar and track cranes, hoists, pumps, derricks, compressors, rock drills, tractors and various small power and hand tools. The list is long and the items are various. Standardization of equipment, therefore, is not a process of simple unification but of multiple unification. There is no common denominator for the standardization of construction plant; each line of equipment presents its individual problem. It is not easy to simplify and standardize under these conditions.

But a greater obstacle exists in requirements which arise from the nature of the construction business. They are: (1) the necessity at times of purchasing special machinery for a special job, (2) the necessity of quick purchase in emergency jobs where quick delivery is important, and (3) the necessity of keeping up to date by the purchase of always the most improved type of machine. All these are essential requirements of the constructing business and they all tend to disrupt the contractor's program of standardized equipment. They therefore deserve some enlargement.

Special Work—There are many construction operations where a special piece of machinery is required to do the work economically. It is bought because the constructor's business is primarily to make money—not to maintain equipment standards. When this special machine has served its purpose it remains an item of plant and of plant investment and often one which cannot profitably be disposed of. All that can be done is to turn the machine to other work for which perhaps it may not be best fitted but for which it must be made to serve as well as possible because it may not stand idle. Obviously it is an oddity in the standards.

Rush Jobs—Again, work has to be done which classifies as emergency or rush work and in conducting which time is the controlling element. Here the contractor may not be able to get quick delivery of the machine on which he has standardized and therefore is compelled to buy another kind and make. And once more the standard line displays an oddity.

Keeping Up to Date—It is obsolescence, however, which most persistently upsets the maintenance of standards. Through improvement, machines become so changed that long before their working life is over they are obsolete as compared with newer ones even of the same type and make. Then again, another maker than the one standardized on may develop such revolutionary advances that there is no resort, if the contractor is to keep his plant up to date, but to buy the new and different machine. Here again is a situation which interrupts standardization.

Advantages of Standardization

Altogether, however, the advantages of standardization greatly outweigh the disadvantages. It is particularly impossible to give specific figures which may be safely used, but there is no doubt of actual savings all along the line of equipment upkeep and operation. To illustrate from the experience of our own construction organization: We find (1) a great reduction in the number of spare parts carried, (2) increased speed of making repairs (*a*) because of greater availability of replacement parts and (*b*) because of the close knowledge by the repairmen and operators of the standard machine, (3) increased interchangeability between machine and machine and between job and job, and (4) increased operator efficiency through constantly working with machines all alike.

We own and operate, for example, a considerable number of double-drum hoisting engines. We make a large saving in the matter of repair parts by carrying parts for one type of machine instead of more. This applies to almost every line of plant where standardizing

is possible. Consider, for example, a tunnel job where 40 or 50 drills must all perform day in and day out over a period of several years, and it is essential that parts be continually replaced—the advisability of using one type of machine is evident if economy is to be obtained.

With the trend from steam to diesel and gasoline-powered machines, the advantages of standardizing are again apparent, for here not only does the bill for repair parts govern but the labor item in the field, we believe, is also affected. When a contractor owns a number of shovels, compressors, etc., alike or at least of the same make, his engineers become expert in the maintenance and operation of these machines and get to know just what each machine needs and what it will do.

For economy of interchange, let us consider the matter of the concrete chute. A contractor purchases chutes for three jobs of 500 ft. each. The next three jobs need 800 ft., 900 ft. and 300 ft. It can be immediately seen that the purchase of the same kind of chutes on the first three jobs saves money for the contractor on the second job.

Take a job requiring several caterpillar cranes, shovels and draglines. If the machines are all of different makes, shovel booms, dipper sticks and shovel dippers and crane booms are possibly required for all, whereas with one type of rig interchange is quick and easy.

What Contract Experience Shows

Altogether the advantages of standardization greatly outweigh the disadvantages. It is impossible to give specific figures which may be safely used, but there is no doubt of actual savings all along the line of equipment upkeep and operation. Standardization by the contractor saves time and money. It is not simple and easy, but calls for thoughtful planning and study and wise discrimination between profitable and unprofitable extension

Conclusion

Standardization by the contractor saves time and money. It is not simple and easy, but calls for wise discrimination between profitable and unprofitable extension.

Electric Power Possibilities for Construction Equipment

Obstacles to Progress Outlined—Outstanding Applications Described—Welding, Lighting and Heating Highly Developed—Large Operations Afford Greatest Opportunity—Electrical Consciousness Needed

By R. C. Muir

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EVEN in construction operations of comparatively small magnitude, man power is no longer a competitor; instead, the question is which form of motive power can be employed to best advantage to drive the machines developed for the purpose. Except for a few devices, electricity has not played the major rôle in the development of construction machines and equipment.

Reasons for Lag in Electrification

The first step in electric drive was to use an electric motor in place of some other form of drive. Gradually it was found that the machine and not the motive power was the limiting feature, and later developments have been along the line of designing machines primarily for electric drive so as to take the full advantage it offers in the way of concentrated power, small space requirements, light weight, high speeds, ease of control and flexibility as to location.

It is not without justification that the construction industry has been slow in getting under way with the general use of electric power in its operations, as it has had to contend with numerous obstacles. The equipment manufacturer could not develop machines primarily for electric drive, because the contractor did not demand it; the contractor could not demand it, because he was not assured of a power supply promptly at an attractive cost; the power company could not assure an attractive cost due to the expense attached to a temporary service connection, the temporary character of the load and in many cases the high load demand compared with the actual energy consumption.

In large or major operations the power requirements are large enough and of long enough duration to make it attractive to the power company, or in isolated locations to make a temporary electric plant attractive. In many instances it has been found feasible and desirable, at the time building operations began, to install service connections of sufficient capacity to cover the ultimate power requirements of the completed building, thereby relieving the contractor of a large part of the service cost. In several large cities equipment companies have made a business of renting electrically driven machines and devices to contractors and arranging for electric service with the power company, thus relieving the contractor of investment costs and making it easier for the power company to negotiate a service contract.

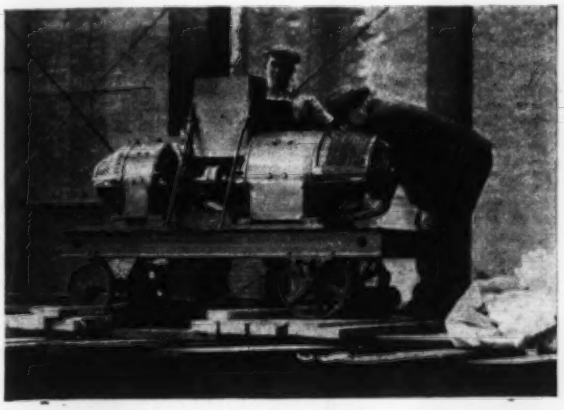
These entering wedges have demonstrated that electric power has so many advantages in construction operations that the demand is growing, ways and means are being found to obtain power on a basis attractive to both the contractor and

Electric power has been only slowly adopted for construction equipment (1) because electricity has not been generally available at suitable prices and (2) because the peculiar advantages of electrification are fully realized only in machines designed for it. There are very great merits in electric power for all the machines and tools used in construction where the machine is designed for motor operation and where the power current is available at reasonable costs. There are other uses, as welding, lighting and heating, where it has a unique place in servicing construction. This article is a reasonable and logical appraisal of the present situation and of future possibilities

the power company, and with the increased use of electric power will come the demand and then the development of machines designed primarily for electric drive and the demand and use of electrical machines, devices and appliances which will assist the contractor and builder in carrying on their work with greater efficiency.

Particular Equipment Applications

There is very little in the way of new electrical developments made primarily for construction operations, for



WELDING SET FOR STEEL BUILDING CONSTRUCTION

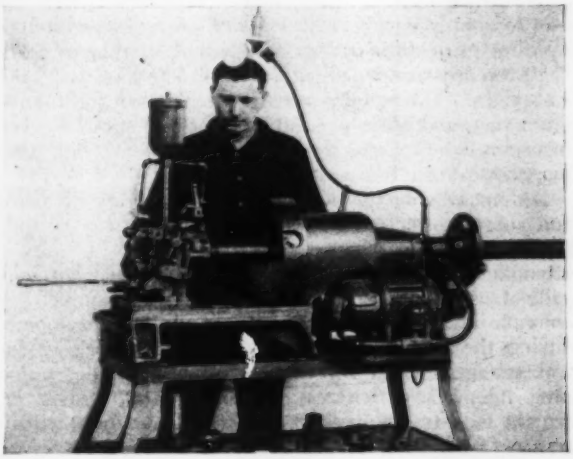
the reason that the demands of the industries at large have been so extensive and varied that suitable electric equipment has generally already been developed and is available. Motor and control designed primarily for material-handling equipment—such as cranes, ore bridges, car dumpers, unloaders, skip hoists, elevators and the like—are very well suited for the operation of derricks, hoists, winches, etc. General-purpose motors and control are well suited for driving pumps and concrete-mixers and for other miscellaneous applications, although in this connection motors with special insulation and recently developed totally inclosed, fan-cooled motors might be used to advantage where the surrounding conditions as to moisture, dust and dirt are unfavorable. High-torque motors developed for various industrial applications are especially suited for conveyors.

Air Compressors—Most major operations require a sizable air-compressor installation, and here the highly developed synchronous motor fits in nicely. For the small portable air compressors, there have been recent developments in motors and control in the way of modified standard equipment to make it especially suited for the severe vibration, as well as for the unfavorable conditions as to exposure incident in the operation of these machines.

Portable and Hand Tools—A variety of small portable tools used in the carpenter shop, machine shop or directly on the work—such as saws, lathes, sanders, grinders, buffers, pipe threaders, drills and the like—are all available with built-in motors and control developed especially for these machines, and there is continued progress in this direction. Small electric hand tools frequently found invaluable for certain small jobs are already quite highly developed, but each year shows some new developments.

Power Shovels—While the electric shovel is not used extensively in purely construction projects at the present time, its rapidly increasing use for quarrying, mining, coal stripping and the like indicates that it may have great advantages in construction work in many cases. It is a good example of a highly perfected machine designed formerly for some other motive power and then especially for electric power, which has permitted the design and operation of much larger units than would have been possible with other forms of motive power. The gas-electric type is available in smaller sizes for use where electric power is not available and, as one manufacturer puts it, "Gasoline for power, electricity for flexibility." The flexible operation is obtained by the use of separate and independent motor drives for the hoist, swing and crowd. The motors are direct geared to these motions and deliver their power in the same manner as the engines of the steam-shovel, giving high speed under light load, low speed under heavy load and stall with maximum pull under extreme load.

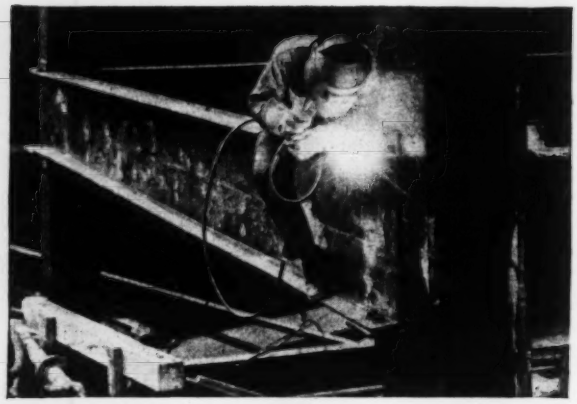
Arc Welding—The development of the art of electric arc welding in structural steel work is probably the most outstanding and promising of any of the recent developments. Electric arc welders driven by electric motors or gasoline engines are available as a standard article in either stationary or portable units. Electric welding is



MOTOR-DRIVEN PIPE-THREADING MACHINE FOR THE JOB

now employed in a wide field of steel construction. The complete framework of several buildings has been entirely welded and the trend is toward this construction. In the construction of ships, pipe lines, large tanks and bridges and in the strengthening of present bridges electric welding is being used to an increasing extent. Improvements in the design of steel structures are being made with a view to realizing more fully the advantages of electric welding in the way of saving material and labor. The forward-looking architect, engineer or contractor will keep a close watch on this development.

Electric Heating—Electric heat also has a field of application in construction. A new strip electric heater of 500-watt capacity has been recently developed, which should find wide application in cabs and pump houses and in various other locations where it is desirable to keep the temperature above the freezing point or where heat is needed for the comfort of the operators. The electric glue pot and the tool room furnace are finding some application in the temporary machine shops and carpenter shops.



ELECTRICAL WELDERS AT WORK ON STEEL FRAMEWORK

Job Lighting—Floodlighting of construction projects has many advantages and is being applied more generally. The results are greater safety to workers, work is speeded up and 24-hour day operation is feasible if necessary. Proper illumination is obtained by light sources from out-of-way points and the equipment is easily transported with minimum effort and low expense due to simple wiring. A new line of lightweight floodlighting projectors particularly suited to this work has been recently developed in 250-watt, 500-watt and 1,000-watt sizes. The metal parts are non-ferrous and immune from rust, and other precautions in the design have been incorporated to make the projector weatherproof under most severe conditions.

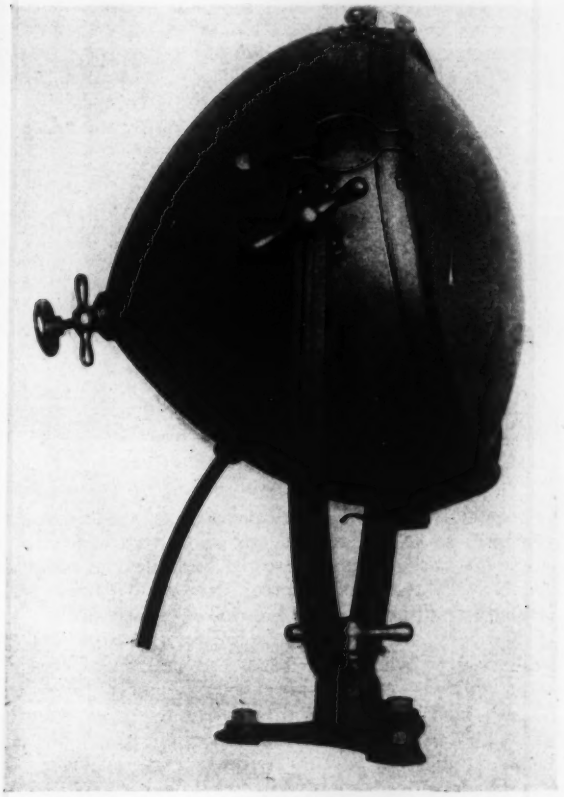
Automatic Control Installations—Flexibility of motors and control offer many possibilities in the way of automatic operation which might show real savings in attendance and labor. Sump pumps operated automatically from float switches are a simple example. An example involving more complication is the development during the past year of an ingenious interlocking control system devised for the operation at predetermined time intervals of chutes delivering sand, gravel and cement to a traveling belt so as to secure automatically an accurate mixture for concrete. With the great variety of motor and control equipment available, there are possibilities of devising many schemes of operation without excessive first cost which will bring about a saving in labor and more satisfactory work, particularly in large construction operations.

Large Construction Operations

As intimated early in this article, large construction operations were largely responsible for disclosing the benefits of electricity, and it is in such undertakings that the use of electricity is more or less taken for granted and, consequently, where the development of its use is being perfected. In undertakings referred to in these pages—such as the Cascade tunnel, the Moffatt tunnel, the Coolidge dam, the Pardee dam and the New York-New Jersey vehicular tunnel—electricity was invaluable. In the new 19-mile aqueduct tunnel for the New York City water supply it is interesting to note that approximately 30,000 kw. capacity in electrical apparatus will be used and power will be purchased from power companies in the vicinity. For this undertaking there will be sixteen automatic Ward-Leonard hoists developed especially for this job, 46 storage battery locomotives designed particularly for this undertaking and sixteen synchronous motors of 400 hp. for driving the air compressors. On projects such as this, the engineering experience obtained in mining, material handling and the industries at large is available so that full advantage of the possibilities of electric power can be realized.

Conclusion

It appears at the moment that what the construction industry needs most is the development of an electrical consciousness, as it were, whereby greater use of electrical apparatus would be made. With the more general use would come a demand for new electric devices and machines requiring new electric motors and control, and if past performance can be relied upon, the manufacturers of electric equipment can be depended upon to keep pace with the demand of the industry.



SWIVELING FLOODLIGHT FOR FIELD USE

Building Codes Allow Welding

Thirty-eight municipalities on the Pacific Coast now have sections in their building codes covering the electric welding of buildings, according to an item in the *General Electric Review* for April. This has resulted from the adoption by these cities of the uniform building code compiled by the Pacific Coast Building Conference, an organization made up of building inspectors and commissioners. The cities now operating under the regulations laid down by the uniform building code have followed the lead of Sacramento and Alhambra, which adopted that code late in 1927. According to the new building code, it is now legal for the commissioner of buildings in each city to grant permits for the erection of electrically welded steel building frames.

Advance in Equipment Engineering

Starting With the Craftsman, Progressing With the Engineer Inventor and Culminating in a Design and Research Staff of Engineers, Equipment Engineering Has Attained a Standing of High Technical Character

By E. H. Lichtenberg
Engineer, Kochring Company, Milwaukee, Wis.

HOW, where and under what circumstances does construction machinery originate? What, in successful practical production, is the process of evolution to the finished machine from an idea in someone's mind or from plain need for a suitable type of machine to perform a specific construction operation? Obviously a number of factors are involved in the unfolding of the answers. Broadly the reply is that in every modern equipment-manufacturing plant there is assembled a force of engineers, technicians and specialists who devote their entire time to p'anning, designing and improving equipment. Modern construction equipment is the expression of engineering in all its methods of creative work. This was not always so. Indeed, it has come to be so within a short time.

Period of the Craftsman

In the early days of equipment manufacture, engineering was almost unknown in the factory. Looking back only a generation, construction machinery was so limited in variety and was constructed in such a crude, simple manner to meet the slight needs of the time that the engineer was practically a negligible factor. Then the tremendous construction requirements of the world had just begun to manifest themselves. The motor vehicle with its insistent demand for roads and bridges had not been realized as a family and business necessity. The great programs of land reclamation, flood control, power development, sanitation and water supply, building, and private and public works generally were all to come. The production of equipment had its very modest beginning in these early times.

Equipment production today calls on every resource of engineering. It is no longer the accomplishment of the inventor and the shop craftsman. An engineering staff often running into scores of specialists designs modern construction equipment. In their work these men call on research and tests in every field of engineering, they follow the development of invention and they keep in close touch with construction in the field. They work as closely to ideals of economy, durability and appearance as do engineers in any branch of the profession. Machinery for construction is not a fortuitous creation, but a purposefully designed tool. It is to explain how all this is that Mr. Lichtenberg, a trained equipment engineer, has prepared this article. It will repay every user of equipment to read it that he may know the extent and quality of his engineering resources

Then also the manufacturer, perhaps having a vision of the great development to come—the necessity of enormous movements of materials—but curbed by the infancy of construction, had himself to be the originator. A man of ingenuity and practical experience, he inspired creation. In his shop those fine mechanics of a past generation, trained in all phases of shopwork, developed his ideas by their practical skill.

The manufacturer and the shop mechanic were the progenitors of a movement that was to demand later from the trained engineer the ultimate capacity of that profession adequately to meet the machinery requirements of the construction field. In those days the templet and the gage were more familiar than the blueprint and specification; the blacksmith, usually an inspired artist in the fashioning of metal, and the carpenter were the important members of the shop organization. Some of the machines manufactured under such crude conditions are still at work rendering service in the construction field, monuments to the fine skill and purpose of these pioneers.

The Period of Inventive Engineering

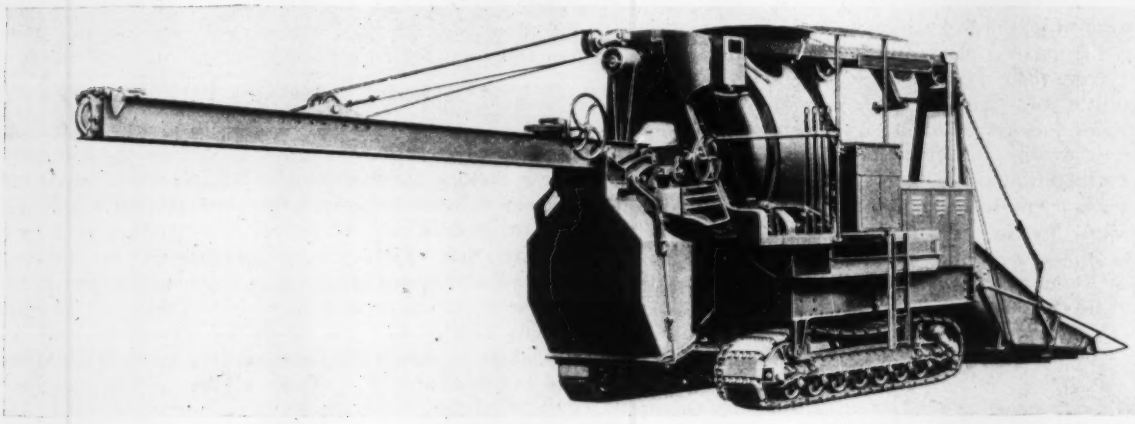
The advent of the engineer into equipment design came logically (1) to bring the growing needs of the contractor to the factory and translate technically these needs into efficient designs for machines to accomplish a job, (2) to provide drawings for the manufacturing processes of all parts, and (3) to prepare specifications for the purchase of correct materials. The engineer was not at this time concerned so much with the development of engineering routine nor had he in his immediate staff any specialists to search for developments along certain lines and advise him on new design. The engineer was faced with increasing new requirements from the field. An inventive mind was needed to meet these conditions. New ideas in machinery must be provided. Greater production in the moving of material and the placing of concrete was constantly insisted on. The simple open machinery transmission was passing and the engineer sought advanced methods, inclosed units, fine steels, heat-treating processes and all the phases of machine design that would produce machines able quietly and efficiently to produce greater results.

Now the Staff of Specialists

Let us examine the organization, the working plan, if you will, of today's engineering staff. It is far indeed from the era of the manufacturer-shop-mechanic team. The modern equipment manufacturer's staff of engineers consists of a large group of highly trained specialists. Their services are specialized. For instance, a structural engineer calculates and designs the structural steel frame; a mechanical engineer designs the transmission; another the crawler traction; another is a specialist on certain functions that the machine is intended to perform; another specializes on automatic mechanism, and another studies the action of materials and their control to meet the increasingly rigid specifications of the field engineers and scientists. An automotive engineer is on the staff to bring to the machine the practice of automotive design in all its phases, affecting materially the practice of the shop forces. An electrical engineer works out the requirements of the electric devices.

All these engineers work in co-operation and under guidance to produce a piece of equipment that (1) will

perform well in the field, (2) has parts that can be made with the available shop equipment and therefore be economically manufactured, and (3) looks well. It may be a far cry from art to construction equipment, but nevertheless all like to see balance, proportion, composition, harmony and graceful lines in a piece of equipment, be it tractor, grader, shovel, paver or what not. It is not always easy to incorporate the various elements into a design, but the engineer must not fail to make the attempt. It does not increase the cost of the unit but should decrease it. A machine, moreover, that looks well, is nicely proportioned and is well balanced usually performs well.



COMPACT SIGHTLINESS DISTINGUISHES MODERN EQUIPMENT DESIGN

A Chief Engineer Co-ordinates

Co-ordination and guidance of the staff operations is the task of the chief engineer. His is the duty to see that their efforts produce a good line of equipment that is readily salable. The product must be salable. This is vitally important, because obviously to produce a machine that has no sale command is time and money wasted.

The clerical staff of the engineer includes the junior draftsman, skilled in carrying out the ideas of the engineer in practical form to suit the pattern shop, foundry, machine shop and erecting departments, and also a chief clerk and assistant whose duty it is to transmit orders and instructions to the shop and take care of records and drawings.

Tasks Are Comprehensive

A knowledge of patent practices is required. An important duty of the equipment engineer is the patent protection of ideas for the manufacturer. All ideas that are patentable are covered properly in the Patent Office. This work assumes large proportions in the manufacture of an extensive line of equipment. Drawings and cases to be prepared are filed and followed up. This is the special duty of an engineer through and with the patent attorney. A continual search through patent records for developments in the construction machinery and other fields is the constant care of the engineer. His vigilance in this task is of the utmost importance to the interests of the manufacturer, so that he does not encroach on the rights of others.

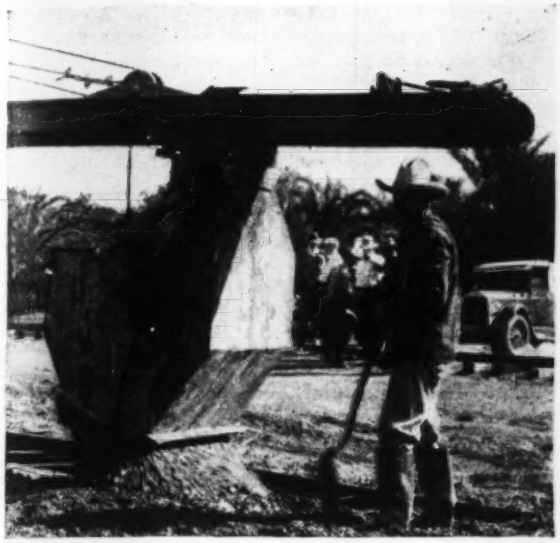
The equipment engineer has constantly to search for new developments in power producers to meet the needs of the contractor and conditions under which he works. In this search he consults with the expert technicians of the universities, tests are conducted, results are tabulated and deductions are obtained from the surveys of the consulting engineers. These reports are studied and the findings are used by the staff of the engineer as conditions warrant.

The engineer from his experience must advise and aid contractors in all parts of the country in the proper use of all kinds of materials as they affect the machine. The specifications of the state highway departments are studied by the experts on the engineer's staff and investigated in the field. The equipment engineer is actively interested and co-operates closely with highway engineers, civil engineers and architects. A knowledge of the highway engineer's aims, of the transportation problems of the state and the city, are the equipment engineer's responsibility. An active participation to formulate solutions for these problems and the mutual interchange of suggestions and ideas is a necessity for the growth of construction.

The engineer has to investigate machines in the field to substantiate ideas started and to obtain a new conception of the contractor's needs. A constant contact with the ever-changing conditions and specifications is very important. It is important not only for the engineer but also for his staff to view the results obtained from new devices and bring back approval or disapproval for the production of these devices in quantities. A knowledge of the contractor's immediate problems and a sympathetic and intelligent interest in approaching them are necessary in the engineering staff correctly to prepare for future needs. These the engineer must obtain from the sales representatives in the different territories so that any new design may answer the requirements of each particular locality.

From the foregoing it can be seen that equipment engineering has advanced to a place well to the forefront with other branches of the engineering profession. Although machine design is its main purpose, it performs a broad service to the constructors seeking quicker and better ways of doing the nation's work. Machinery designed for construction involves all phases of engineering, automotive, electrical, structural, mechanical, hydraulic, hoisting, chemical, concrete, highway, and civil. In the degree that the equipment engineer and his staff understand and apply these phases of engineering to their product, so will the machines fulfill the needs of the constructor.

When a design is found that has merit and is exten-



A BUCKET THAT CAME AS A FLASH OF INSPIRATION

sively used and becomes familiar to the public, it then must be a characteristic of each succeeding model and express the individuality of the manufacturer, just as each member of a family shows certain characteristics of that family. Thus a mechanical policy is established which supersedes and dominates every other policy that the manufacturer may have. It is by no means easy to give each succeeding new model this peculiar characteristic, because with time and changing engineering personnel, the mechanical policy is often overlooked to the detriment of the manufacturer.

There are numerous examples, and no doubt the reader can easily recall manufacturers who have lost their individuality as expressed in the design of their product and have become merely another manufacturer, or have gone out of business entirely. There are also numerous examples of manufacturers who have held steadfastly to a mechanical policy to their advantage and profit. For instance, a leaning wheel has become the outstanding characteristic and mechanical policy of one manufacturer. In another the characteristic design or graceful lines of the machine expresses the maker's individuality. Surely no one has mistaken a Packard automobile for some other car, regardless of model and regardless of when and in which year it was built.

Where Ideas Originate

New ideas for machines or improvements are of three kinds:

1. Those that come as a flash and then are put into tangible form. For instance, an engineer while on a train glanced out of the window of the car just as a paver working on a road dumped concrete out of the old-time boom bucket in a heap. The thought suddenly struck him, "Why not turn the bucket around 90 deg. and dump the bucket crosswise while traveling, thus spreading the concrete in a broad ribbon?" This was soon afterward done, and as a result the labor of thousands of men has been saved.

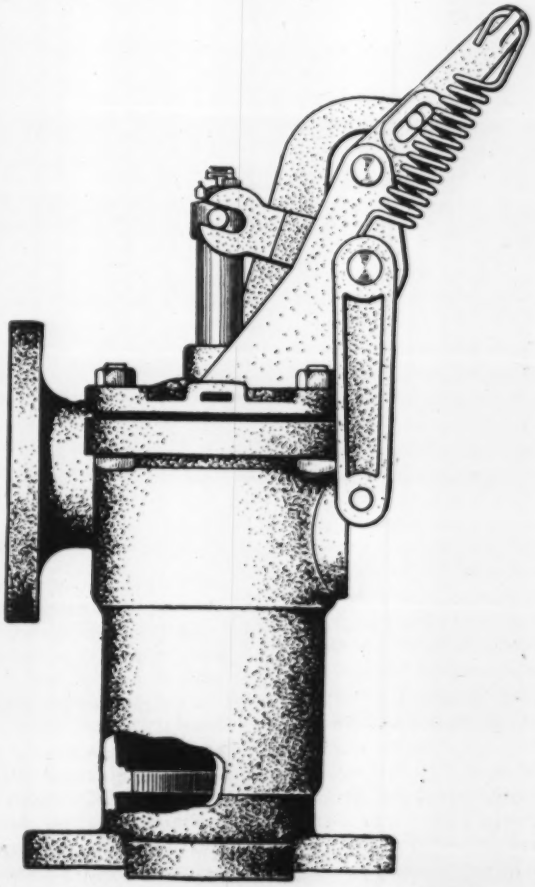
2. Those that come after making extensive experiments and which may not have any relation to the original purpose of the experiment.

3. Those that have no form or outline, but are merely in the nature of a future ideal. To illustrate: For years the water valves on mixers were a source of much annoyance because of the dirt, rust, gravel and constantly varying high pressures in the water. Various valve manufacturers were consulted; a form of valve was constructed, tested and discarded; another form was built and relegated to the scrap heap and another and another until finally, after eight years of experiments, trials and tests a mechanism was built which somewhat approached the original ideal.

Scientific Approach Paramount

There are many problems which confront the engineering staff of the equipment manufacturer, but each is and should be approached scientifically. That means, as it has been said, first to find the simplest possible statement of the problem. That is generalization from the faculty of imagination. What is the problem? Having got it clearly in view, the next step is one of analysis. Break the problem down part by part. This is research, or fact finding. The third act is that of synthesis. Weigh the facts, evaluate them, reconcile them; then put them all together again and regard the problem as a whole. As a whole, its appearance is not the same as it was before analysis. The change is owing to the fact that now there is exact knowledge of the problem's inwardness; this knowledge plays on its outwardness and modifies it in a significant manner.

There is indeed no seeing a thing whole without analysis. What one sees as an illusion of the whole is merely the surface and not all of that from any one view. One



LATEST STEP IN AN EIGHT-YEAR SEARCH FOR AN IDEAL

could never know what a motor car is from looking at the outside of it. By driving in it you may learn what it can do, but you will not know if it is making the right sound or what a sudden change of sound or behavior signifies. Having broken it down and built it up again, then you know and see it in an altogether different way.

That is all there is to the scientific approach in principle. It is the same to an economic difficulty, to a problem in physics or to a piece of intricate mechanism. First the imagination to generalize the problem, which is to isolate it for the purposes of action and then analysis and synthesis, all to the end that judgment may be informed by exact knowledge.

Indeed, it is this searching for knowledge by the equipment engineer which has freed the construction industry from the grind and drudgery of an old order of things. Only by man's advancement in the mechanical mastery of construction has this new freedom been made possible

Equipment Standardization an Economic Need

A Discussion of the Accomplishments and Opportunities in Simplification and Standardization of Construction Equipment—Economic Gains Shared Alike by Manufacturers, Contractors and Building Public

By C. S. Embrey

Assistant Engineer, Associated General Contractors, and Secretary, Mixer Manufacturers Bureau, Washington, D. C.

MILLIONS of dollars are spent annually for construction equipment designed and produced almost solely upon the individual judgment of the manufacturer. Improvements in design and efficiency have crowded one another in almost endless succession, and numerous types and models of every type of equipment have been put into production and on the market. Sizes are too close together and models are too numerous, in many instances differing from one another but slightly. Equipment produced by one manufacturer often differs considerably in measured capacity from that of another, although in both instances the nominal rating is the same. There is in the whole situation a definite economic waste which can and should be gradually corrected.

Economic Situation Pressing

Neither the manufacturers nor the contractors who purchase their products have until recent years given much thought to the economics of the situation. There is now, however, a gradually awakening realization on the part of both that some form of control is desirable. Competition is not lessening for either the manufacturer or the contractor, and there is a growing conviction that a conscious effort to control investments and expenditures in construction equipment will have an acceptable effect upon the profit column. The production of numerous sizes and models differing but little from one another and not all having a ready sale is proving burdensome to manufacturers. The early obsolescence of expensive equipment by the frequent introduction of new models and sizes is likewise a heavy financial burden on the contractor, and he finds it difficult to pass this along to the public, even while reluctantly appreciating the necessity to do so if he is to stay in business.

Equipment standardization is thought by many manufacturers and contractors to be a satisfactory solution for all concerned. At the present time industrial standards relating to size, capacity and performance in the construction equipment manufacturing field are virtually non-existent. The performance standards covering safe loads and tipping capacities adopted in 1921 by the Locomotive Crane Manufacturers Association, and the concrete mixer standards promulgated in 1924 by the Mixer Manufacturers Bureau in conjunction with the Associated General Contractors of America, appear to be, after a search of accessible records, the only contributions.

Concrete mixer standardization has been successful. For a number of years the mixer manufacturers have produced a simplified line of sizes with standard capacity ratings. Savings in costs estimated at an average of 7 per cent have been realized, and trade practices have been greatly improved. The standard sizes of mixers and pavers have proved adequate to the needs of the contractors, and the results have been beneficial to all. No changes in sizes or capacity ratings are made except by agreement between the manufacturers and the contractors.

The accompanying extract from the provisions of the Concrete Mixer Standards, fourth revision, is illustrative of the control made possible through standardization when it can be stated that members of the Mixer Manufacturers Bureau, who are collectively responsible for 97 per cent of the total production of concrete mixers and pavers in the United States, subscribe to and are bound by the standards. The standardization of construction equipment consists of two distinct operations: (1) the elimination of unnecessary sizes and models, which may be termed simplification; and (2) the standardization of capacities or performance of those which remain. Further standardization relating to mechanical features may or may not be desirable at the outset of a program or at some stage thereafter, but whether or not such refinement is ever undertaken, the important economic objective is attained through the first two steps.

Salient Facts

The production of numerous sizes and models is proving burdensome to equipment manufacturers.

Early obsolescence by frequent change of size and model is a heavy financial burden on the contractor.

Concrete-mixer standardization has been successful; 97 per cent of the output is standardized at an average saving in cost of 7 per cent.

Standardization is possible to some degree in every line of construction equipment.

Standardization does not halt progress in the improvement of construction equipment; individual initiative is not stifled; the manufacturer is free to develop his product to any maximum of performance, durability and utility.

While standardization can be successfully initiated and kept in force by the manufacturers themselves, the work can be made easier and more quickly effective if the counsel and co-operation of the contractors is sought. The Associated General Contractors of America, representing a large cross-section of the contracting fraternity, can and will be helpful to any group of manufacturers in determining matters of size, capacity and style, promulgating standards and keeping them in force.

Standardization can gain a toehold somewhere in almost every line of construction equipment manufacture. It would be possible for the manufacturers of cranes, excavators, backfillers, power shovels, trenching machines, derricks, hoists, tractors, trucks, excavating and material-handling buckets, road-grading machinery, portable elevating and conveying machinery, batch boxes, industrial haulage equipment and other items of equipment to find points upon which standardization programs can be based. Such programs need not be far-flung nor intricate to be effective and beneficial. They need not at the beginning be of such a drastic nature as to work undue hardships on the manufacturers.

Benefits of Standardization

Where a determined effort toward standardization is made by any group of manufacturers, it should be but a short time until its beneficial effects are felt. Greater efficiency in the shops and reduced production costs should follow. Dead stocks of unpopular sizes and models for which there is no steady demand are eventually eliminated and the manufacturer is relieved of the investment in this class of machinery. Money and production facilities and sales effort can be concentrated upon sizes and models for which there is the maximum demand. The manufacture and stocking of repair parts can be controlled in a manner which permits of a high degree of efficiency in servicing the consumer, while keeping the investment and cost of stocking and handling at a minimum.

Standardization should relieve numerous aggravating and costly competitive sales practices. When manufacturers in a group are well started on a co-operative standardization program they are relieved of the necessity of out-thinking one another in the matter of producing new models to catch the trade. They find themselves engaged in making the same sizes and capacities, and can turn their energies toward developing their individual products to the highest degree of efficiency. The necessity of meeting "something new" put on the market by a competitor is greatly lessened.

Standardization does not stop progress in the improvement of construction equipment. Individual initiative is not stifled and the manufacturers are still free to develop their products along lines of performance, durability and utility. Standardization seeks only to check unwarranted changes in sizes and capacities brought about by uncontrolled competition. It has the effect of substituting intelligent group action for individual enterprise.

The question of obsolescence is a serious consideration to the contractor. With standardization he has fair assurance that the investment he makes today in an expensive machine will not be quickly impaired by the appearance on the market of a new model shortly after he purchases. The frequent introduction of new models often has the effect not only of making obsolete earlier ones before their time but of seriously affecting the economic usefulness of other equipment operated in conjunction with them. In the engineering construction field, equipment represents a large capital investment to the contractor, and the cost of ownership of this equipment is a large part of his charge to the public for construction service rendered. Not only should the machinery be durable and efficient in performance but the investment should not be prematurely depreciated. Standardization will help prevent this, and in taking up such work both the manufacturers and the contractors can promote their own interest and ultimately pass on to the public an improvement in construction practice which should redound to their benefit.

STANDARD SIZES, PROPORTIONS AND BATCHES FOR CONCRETE MIXERS

Standard Sizes:

(*a*) Seven sizes of construction mixers shall be standard and shall be 3½-S, 5-S, 7-S, 10-S, 14-S, 21-S, 28-S, and no intermediate sizes shall be manufactured. For the present, sizes below 3½-S and above 28-S shall not be standard, but may be manufactured by members.

(*b*) Three sizes of paving mixers shall be standard and shall be 10-E, 13-E, 27-E. No other size shall be manufactured.

Proportions and Batches:

(*a*) Standard sizes of construction mixers and paving mixers shall be guaranteed to hold and properly mix the following proportions and batches:

	Proportion and Size of Batch in Bags of Cement									
Proportions	3½-S	5-S	7-S	10-S	14-S	21-S	28-S	10-E	13-E	27-E
1–1¼–3	1	1	2	3	4	6	8	2	4	7
1–1½–3¼	¾	1	1	2	3	5	7	2	3	7
1–2–3	¾	1	1	2	3	5	7	2	3	7
1–1½–3¾	¾	1	1	2	3	5	7	2	3	6
1–2–3¾	¾	1	1	2	3	5	7	2	3	6
1–2–4	¾	1	1	2	3	4	6	2	3	6
1–2½–4	¾	1	1	2	3	4	6	2	3	5
1–2–5	¾	¾	1	2	2	4	6	1	2	5
1–2½–5	¾	¾	1	1	2	4	5	1	2	5
1–3–5	¾	¾	1	1	2	3	5	1	2	4
1–3–6	¾	¾	1	1	2	3	4	1	2	4

Bronze Brick Certifies Materials and Workmanship in Buildings

A bronze brick of conventional size will be inserted in the walls of future brick buildings which incorporate excellence in material and workmanship complying with standards set by the Common Brick Manufacturers Association. The plan was originated two years ago with the Cleveland Ohio Clay League and is now being nationalized by the Common Brick Manufacturers Association. In one of the latter association's recent publications the following is given concerning this certification idea: "It means that the walls of every home so dignified are built of burned clay products, either solid or of hollow Ideal wall construction, or of brick backed with hollow tile; moreover, that the workmanship is first class and the materials as good as or better than the requirements of the specifications of the American Society for Testing Materials. It is the first active co-operation with the U. S. Bureau of Standards in its effort to induce all manufacturers of building materials to certify the quality of their products. Heretofore no house has carried a guarantee covering what is in its walls. Eventually every manufacturer in our membership who participates in this plan will supply bricks which have been graded, after laboratory test, according to the specifications of the American Society for Testing Materials. Expert engineers will inspect all construction to be certified. So when the bronze brick is set into the corner of your house and the district association secretary hands you the certificate which goes with it, you may have the very comforting confidence that your house is as good as can be built. And when you want to sell it, this certification will be worth many dollars to the resale price."

Epochal Developments Made in Equipment Engineering

Mobility, New Kinds of Power, New Materials, Simplification of Structure and Operation, Greater Automaticity, Centralized Control, Elimination of Friction and Functionalization Have Revolutionized Construction Equipment

By R. Burdette Dale
Consulting Engineer and Head Instructor in Machine Design, Pratt Institute, Brooklyn, N. Y.

THIRTY years have witnessed greater advance in the invention and use of machinery for construction than was recorded in all time previously. An inquiry into the basic influences is well worth while. Primarily we must look to the human mind itself. We are becoming machine-minded, or, to state the thought even more directly, power-minded. To build we must dig, delve, drill, cut, crush, mix, move and handle masses of material. There are two ways to do these things, by means of human labor and by power-driven machinery. We have chosen the latter.

The power-mindedness of organized society is one of the most significant and outstanding contributions of the present age to world history and development. No longer is it possible adequately to measure human progress in terms of man-hours of labor; we must use a new unit, kilowatt-man hours.

Operating Speed Multiplied

Such results would not have been possible were it not for certain epochal developments in the progress of the mechanical arts. The first power-driven machines were heavy, awkward, clumsy and inadequate as judged by modern standards. Probably the most important and essential principle involved in their improvement is one which is less readily apparent to the uninformed than to the technical man. It is that, in problems of machine design, power and torque are co-ordinated in that while the power throughout the machine is practically constant, the torque varies inversely as the rotative speed.

High rotative speed for a given power, since the torque is lessened, results in lighter weight, more flexible, more portable and usually less expensive machine structures. Force is a function of torque; if torque is reduced, the applied force is reduced. The constant aim of the machine designer, particularly for certain types of machine structures which lend themselves to this development, has been to increase speeds and thus reduce the torque and consequently the applied forces. Results have not been obtained without effort. Improved materials, advances in lubrication practice, use of friction-reducing bearings, improved technique of design, all these have had an important bearing on the problem.

As applied to contractor's equipment, this principle of the use of higher speeds for the moving parts of machines, and therefore of the machines themselves, has resulted not only in improvements of such machines but also in vast improvements in functionalization. Time is an intensely important element in construction operations, not only in so far as the actual lapse of time required for a given task is concerned but also as it affects co-ordination of time elements required to complete the structure. For example, materials handling must be co-ordinated with operation functions. If this is not accomplished, exasperating and expensive delays are sure to occur. Higher-speed machinery has resulted in regular speed of construction progress, with all its benefits.

Higher Perfection of Structure

The use of improved materials for machine members as such materials have become available, and the greater knowledge of the properties of suitable materials, have had a far-reaching influence upon the design of contractor's equipment Materials of higher strength have been made commercially available. The use of many new steel alloys, for example, has made it possible to reduce total weights, often with increased useful-life expectation for the machine. It has been possible to reduce the design factor of safety because of more accurate stress analysis, greater knowledge of fatigue factors, more accurate control of the quality of the materials used and more accurate inspection control of the finished parts.

Another recent innovation which comes near to being epochal is the more general use of rolled steel shapes in place of heavy castings for machine frames. The art of welding has contributed largely to this change. Improved tools and factory methods for bending, forming, cutting, coping, framing and welding steel members have made it cheaper to use such construction than to use heavy cast iron, involving the use of expensive patterns and core boxes as well as foundry expense.

Working Friction Reduced

Lubrication is another factor which has undergone revolutionary changes. Proper lubrication becomes more and more important as speeds are increased. Not only have the lubricants themselves been greatly improved but lubrication systems with central control similar to those used for chassis lubrication for an automobile, have been developed for all classes of contractor's equipment. Efficient lubrication reduces wear, prevents breakdowns, steps up operation speed, reduces lubricating expense and results in economy of care and maintenance.

Friction is an enemy of the efficient use of power. Friction losses are rather difficult to detect because they are hard to measure. How great are the friction losses in any given machine is a difficult question to answer unless accurate measurements of power input and output are made. The generous use of anti-friction ball or roller bearings has greatly helped this situation. Such bearings have been greatly improved in recent years. Anti-friction bearing technique provides for improved installation, protection from dust and grit, take-up and

adjustment, proper alignment, freedom from vibration and the efficient distribution of both thrust and radial loads. In addition to these very apparent advantages, the use of anti-friction bearings results in increased life of the machine, reduces maintenance expense and cost of operation and increases reliability.

Mobility Sublimated

Astonishing progress in mobility of equipment has been achieved. The practical development of the automobile for commercial purposes has had a profound and lasting effect upon contractor's equipment. Such machinery must be portable, because it is used only temporarily during the construction of the structure. It must be brought to the site at the beginning of the construction period and removed after the work is completed. Certain types of structures, such as hard-surfaced roads, sewer and water main projects and pipe lines, cover a great deal of territory. In jobs of this type the utmost portability is required. Certain other types must combine function with mobility, such as road rollers, scrapers, ditchers, surfacers, pavement layers and power shovels. The development of the track-laying mobile, such as the caterpillar tractor, which travels upon its own road, has made mobility possible on rough, irregular and marshy ground.

Another extreme necessity for portability is demanded by large construction projects in congested cities where storage space is not available. During the excavation period large quantities of material must be immediately removed from the site. The only way in which this can be accomplished in many instances is by trucking the material away through city streets. Trucks with dump bodies which are loaded by power shovels at the site are generally used for this purpose. Not only does the capital investment require that this work be done expeditiously but the traffic congestion in the narrow streets of large cities means that the trucks used for this purpose must be reliable, powerful, flexible and speedy. After the excavation is completed a continuous stream of bulky building materials must be delivered to the site at the proper time and in the required sequence. Adequate and reliable trucking equipment suitable for the purposes just described has been one of the most outstanding recent developments of construction equipment.

A very few years ago, counting time in a relative sense, practically the only functionalized equipment which was readily portable was the mortor-driven sawmill for the wood lot. It consisted of a circular saw mounted on bearings and belted to a gasoline engine. This apparatus was mounted on the running gear of a wagon and was drawn by a pair of horses. At the present time practically all the functionalized equipment needed by the construction contractor may be mounted on a self-propelled vehicle. The applications and arrangements are legion. Power equipment may be provided with a separate power plant, or the power may be obtained from a power take-off on the truck engine.

To mention only a few instances of such functionalized equipment, we may allude to portable derricks and hoists, power-driven pumps, gasoline-motored electric generators for lighting, welding and other purposes, air-compressor units, motorized firefighting apparatus, manhole and cesspool cleaners, street sweepers and sprinklers, power shovels and excavators, pavement surfacers, road rollers and scrapers, concrete mixers, rock crushers, tar heaters and mixers, piledrivers, sandblasters and pneumatic painting machines, cement guns and many other applications. One manufacturer of commercial trucks reports the application of more than 200 different types of functionalized equipment, more or less standardized, which have been mounted on trucks of his make. The possibilities in this field appear to be limited only by the ingenuity of the designer and the demands of the user.

Power Plant Revolutionized

Light, powerful and flexible motors using gasoline as a fuel have been developed. Because of the enormous demand for these engines, factory production methods have been so perfected in the automotive industries that these motors may be built to sell, with the chassis or separately, at an astonishingly low price. Such motors are remarkably safe, reliable and easy to operate in comparison, for example, with steam-driven motors. A comparatively new development in America consists of motors using heavy oil for fuel. Progress here is in its infancy, but many engineers believe that the heavy-oil engine will be the power plant of the future. Developments are being watched with unusual interest.

Functionalization Increased

The functional performance of equipment has taken on new meaning. Functionalized equipment may be of two kinds: single-purpose machines and multiple-purpose machines. Motorized multiple-purpose equipment is used for more or less standardized but complex tasks. For example, the making of house service connections for public utilities involves several separate tasks. It may be that the surface of hard pavement must be broken and removed. A ditch must be dug through hard soil. Tree roots must be removed. Tunnels must be run under concrete sidewalk. The main must be tapped and the service pipes connected. After the service is installed the excavation must be filled, the earth tamped back into the ditch and the pavement replaced. For this service a portable air compressor mounted on a high-speed motorized chassis is provided. With this goes a suitable air hose with reel and a full complement of pneumatic pavement breakers and diggers, pipe-tapping machine, pneumatic winch and the necessary hand tools.

Many other examples, equally interesting, of multiple-function equipment might be mentioned. A recent machine for a complex task is the "ballast cleaner" developed by the Pennsylvania Railroad. This enormous machine moves continuously along the track, scooping up, cleaning and relaying the rock ballast. There are the more familiar portable rock crushing and screening plants, portable asphalt plants, truck excavators, concrete-paving mixers and finishing machines, and convertible power shovels. The principle behind all is extreme functionalization.

Conclusion

Broad developments only have been considered. What they mean to the constructor scarcely requires emphasis. Just how have these signal developments, the product of inventive genius and engineering skill, during the past few years touched upon and affected society? We are living in a new age, we are thinking new thoughts and our young men are dreaming new dreams. Humanity has greatly benefited by these modern inventions. Transportation and communication have been revolutionized. Industry and employment of labor have been accelerated. Commerce is interlarded with human interest as never before. Civilization is being mechanized—but with beneficial results.

Concrete-Mixer Improvement and Progress

Factors in Mixer Development—Mixer Production Standardized—Mixer Types Defined—Design and Construction Progress—Paving-Mixer Development—Water-Tank Development

By J. E. Bushnell
Chief Engineer, Ransome Concrete Machinery Company, Dunellen, N. J.

THE concrete-mixer, and particularly the special concrete-mixer for paving, has developed almost immeasurably, compared with early commercial mixers, in efficiency and reliability as a machine for producing mixed concrete. Mobility, simplification of mechanical control, automatic water control, mixing-time control, lubrication, better structural design, materials and workmanship, etc., are all characteristics that have been developed in a short period. This article is planned to epitomize this advance and indicate its value in construction.

Factors in Mixer Development

To the architect or engineer the concrete-mixer is a device which partly produces one of his materials of construction. He wants it so to perform its function of converting the cement, aggregate and water into a thoroughly mixed batch that, if he correctly controls the proportioning and placing of the batch, the resulting concrete construction will meet his requirements.

Few machines employed in construction illustrate better the mechanical advances in equipment and the processes followed in equipment engineering than does the concrete mixer, and particularly the paving mixer. Compactness and symmetry, mobility, automaticity and functionalization have all proceeded far in concrete mixers. It is almost unique among construction machines in the fact that it has come to a fair degree of standardization. In this article these points are emphasized in a manner which makes the account of mixer development typify equipment development generally. There are today few functionalized machines which display a higher type of engineering skill than does the paving mixer

To the contractor the concrete-mixer is a tool, part of his construction equipment. Some one of the standard types or sizes will meet the majority of his problems, but occasionally a particular case arises necessitating the development of a special tool and demanding the best that the combined efforts of the contractor and equipment designer can produce.

To the mixer manufacturer the concrete-mixer is a problem in design, production and distribution in competition with other manufacturers of like equipment.

Recently additional groups have joined the above-named three, the interacting interests of which have in the past determined concrete-mixer improvement and progress. The central mixing plant and the device for mixing en route or after arrival at the job are exerting a very strong influence. The water-cement ratio method of proportioning promulgated by Duff A. Abrams has been the major recent factor advanced by the engineering or research group.

Mixer Production Standardized

The mixer manufacturers have added enormously to their relative strength among the groups by forming the Mixer Manufacturers Bureau, which is affiliated with the Associated General Contractors. This organization has adopted a mixer nomenclature, a list of standard sizes of construction and paving mixers, a table of batch capacities for the various sizes, and other standards. It has recently adopted a drum-volume-limit method of determining the acceptable drum size for any given rating. The sizes listed are the standard sizes, and no intermediate sizes are to be built unless the list is changed. Some smaller mixers are built, but the important sizes not listed are the larger mixers, not standardized as yet, but built in 42S, 56S, 84S and 112S sizes. With this well-defined field the manufacturer's efforts are largely confined to developing the mechanical and structural parts of his product and to improvement in its mixing functions.

Mixer Types

The present method of designating a mixer by a size-number which approximates its output in mixed concrete per batch was not always in use. Arbitrary numbers and numbers representing capacity in loose materials per batch have been used. Mixers have not all developed along the same lines; the various types now being offered for sale are as follows:

1. Tilting drum or tub type mixers having one drum opening through which materials are charged and discharged (Fig. 1).

2. Tilting drum mixers having two openings; these are charged and mix with the drum in a horizontal position and tilt the discharge end down to discharge the batch (Fig. 2).

3. Non-tilting drum mixers having two openings and discharging by means of a discharge chute which swings into the drum (Fig. 3).

4. Non-tilting drum mixers having two openings, one of which is closed while mixing and is opened to discharge (Fig. 4).

5. Paving mixers.

It will be noticed that the differences between these various types are almost entirely in the manner of discharge, this being partly true of the paving mixers, which are usually equipped with means for distributing the discharge.

Figs. 5, 6, 7 and 8 illustrate the various methods used for charging. The low charger is economically confined to use on the smaller sizes except in special cases. The batch hopper may be charged in various ways as by wheelbarrow, power-operated skip hoist, direct from batch-measuring boxes or by trucks which have previously received measured batches.

The power charging skip may be of the simple type shown in Fig. 3, or it may have an open end to permit the entrance of trucks for discharging the truck batches. The skip may be arranged to run in an extended track and drop quite a distance below the level of the mixer

frame either by a straight vertical drop or by descending on an incline.

Nearly all of the mixers in the standard list are designed to take, interchangeably, any one of the various charging devices. This is of great value, particularly to the larger contracting units which use a number of mixers. Steady improvement and refinement are to be noted in the increasing flexibility of control of batch-hopper gates, freedom from sticking, etc. Extended power loading skips have been improved by simplifying the track and by arrangements which permit the use of the standard power charging skip by the addition of wheels and axles, whereas the older designs required the use of a specially designed skip of different shape when the extended track was to be used.

Fig. 9 shows a special 27E designed to work in the low overhead clearance of the New York subway rock tunnel construction. Standard 27E skips extend up more than 20 ft. when raised, which would have been much too high, so the contractor had his trucks equipped with special bodies and the mixer manufacturer supplied a special skip. The illustration shows the comparison between the standard and the special equipment, which is an interesting example of what may be done when conditions demand.

Progress in Design and Construction

Early mixers included little more than a wooden frame mounted on wheels, which frame, in turn, carried the mixing drum and means for driving the drum. There was no upper framework such as is now used to carry charging chute, batch hopper or power charger and water tank. These early designs with steam engine and boiler make such a contrast with the neat, clean-cut, compact and workmanlike appearance of the present-day mixer with its efficient and ever-ready gasoline engine that advance is readily appreciated. The ability of these earlier machines to produce concrete with a high degree of efficiency must not be forgotten, however, particularly in view of the fact that some machines twenty years or more old are still in use, their owners still buying occasional repair parts.

Progress in mixer design and construction is not confined to the general outward appearance which the eye comprehends at a glance. It has had as far-reaching an effect on materials, workmanship, detailed design and performance.

Shafts were formerly commercial cold-finished steel running in bearings of cast iron or babbitted or bronze bushed boxes, poorly protected from dirt and indifferently lubricated. In nearly all places where such general construction still survives very careful attention has been given to improved lubrication and to closures to keep out foreign matter. The more modern designs include the use of the highest types of anti-friction bearings available, mounted according to the best accepted engineering practice, to insure freedom from bearing troubles. The shafts are becoming heat-treated alloy steel, gears are changing from the noisy, open types prevalent a few years ago to completely inclosed drives, heat-treated gears, worm gear reductions, etc., leaving only the final drive to the drum open. The concrete-mixer industry, with mechanical engineering in general, is greatly indebted to the automotive industries for developing these improved materials and production practices.

A similar advance is found in those parts of the mixer which come into contact with the materials being mixed. Special-analysis steel plates are being used for wearing surfaces such as mixing blades and pickup buckets, discharge chutes, batch-hopper spouts, etc. In some cases these plates are heat-treated after forming to develop further the properties believed present. It is a time of very rapid progress. As soon as the advantages of any material or type of construction seem apparent they are eagerly seized upon by one or more manufacturers. Not all of these moves will prove of permanent value; a few will be but fads, eagerly bought, easily sold, having their day and then dying out. The general trend, however, is toward an increasingly better product in which slovenliness of design or workmanship has no place.

The requirements of design vary between the small mixers, the intermediate sizes and the larger sizes. The smaller mixers are often moved around by hand in cramped locations such as basements for small houses,

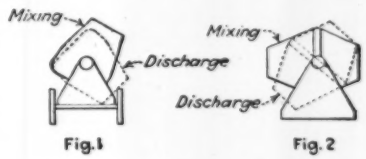


Fig. 1

Fig. 2

Fig. 3

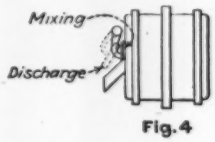
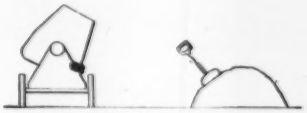
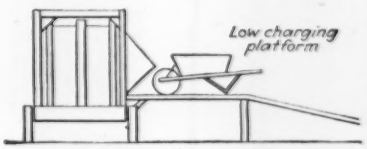
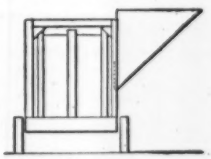


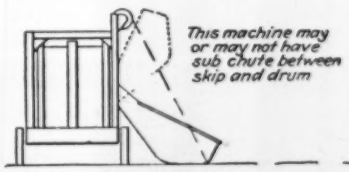
Fig. 4


Hand Charging
Fig. 5



Low Charging Mixer for Hand or Wheelbarrow Charging
Fig. 6


Batch Hopper
Fig. 7



Power Charging Skip
Fig. 8

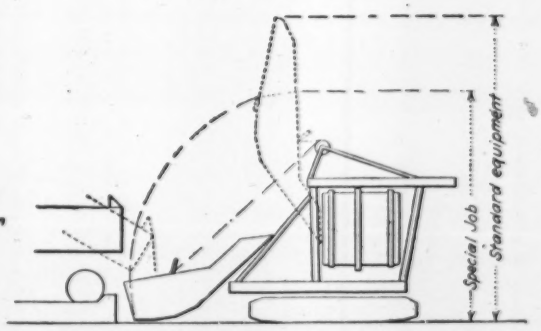


Fig. 9

FIGS. 1-9—TYPES OF MIXER BODIES AND CHARGING AND DISCHARGING ARRANGEMENTS

FIG. 10—OLD FORM OF PAVING MIXER WITH SIDE CHARGE AND END DISCHARGE

so that minimum weight, compact design and the shortest attainable turning radius are essential.

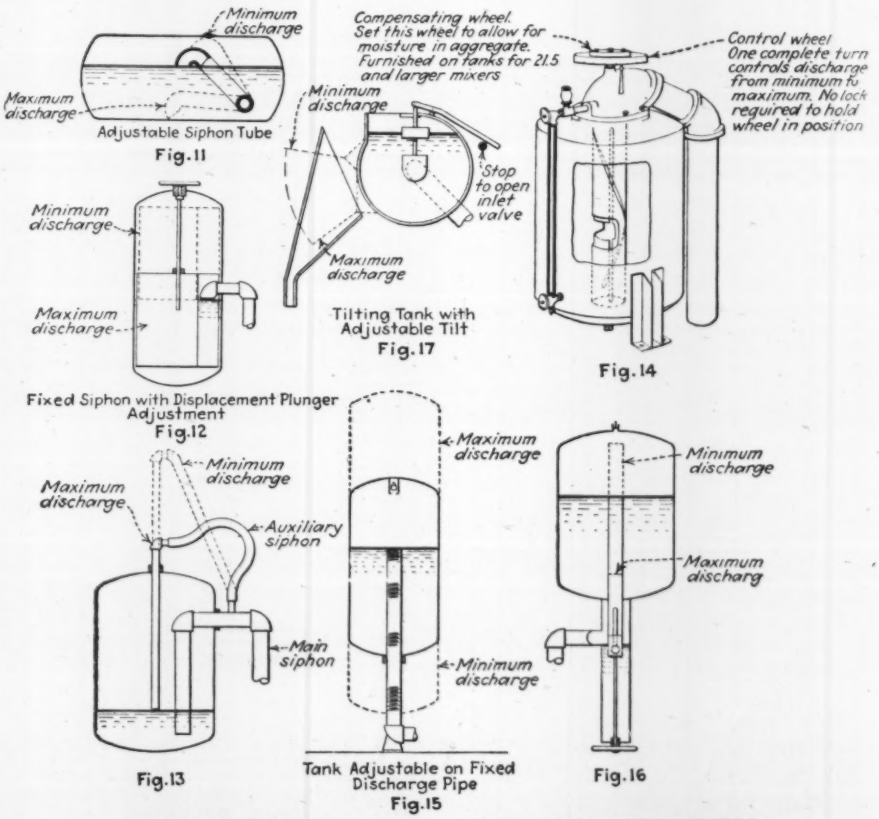
In the intermediate sizes such as the 14S and the 21S there will be difference of opinion as to whether the machines should be designed along the lines of the small, light and easily handled machines or whether to include more or less of the ruggedness and long effective life which should certainly begin with the 28S.

A 28S, 42S, 56S, 84S or larger mixer should be designed for years of steady operation These are central mixing plant sizes and what is a fairly large construction job, say 50,000 to 75,000 cu.yd., is only a start for the average central mixing plant. The mixer manufacturer has already learned this. The central plant owner cannot afford to ignore it when buying a mixer or any other part of his equipment. First cost should be his last consideration and he should insist on securing a machine in which the surfaces on which aggregate or concrete rubs are provided with renewable liners. Other parts subject to wear should be liberally designed for long life and should be readily replaceable. This accessibility for servicing or replacing any part is of paramount importance—any conceivable replacement should not be more than an overnight job. He should inquire into the material used in each and every part, check the methods of manufacturing used to produce the machine and the size proposed to be furnished for a given rating. The modern large mixer will pass his most exacting requirements; nothing less should be tolerated.

The use of the mixer with a tilting drum having two openings (Fig. 2) is becoming more and more confined to the larger sizes, particularly where large aggregate is used such as stones from 8 to 12 in. in size. The question is often asked as to how successfully the non-tilting drum with a discharge chute will handle this large aggregate. It is possible so to proportion a drum, blading and discharge chute that any reasonable size of aggregate may be successfully mixed and discharged. The maximum pieces must not exceed the conditions for which the design has been made.

Paving Mixer Development

One outstanding development of the mixer manufacturer is the modern paving mixer. This machine started years ago as a slightly modified construction mixer with a power charging skip. The suffix S after the size number of a construction mixer means that it is a side-load and side-discharge machine. The suffix E after a paving mixer size number, as 27E, means that the machine is end-charging and end-discharging. Some of the early machines were a combination of these, being side-charging and end-discharging. The early paving mixers, sometimes then called street mixers, were equipped with a discharge chute like that of the construction mixers; this was followed by a long distributing chute and later by a boom carrying a tip-over bucket (Fig. 10). The tip-over bucket was superseded by a bottom-dump bucket with doors opening longitudinally, which in turn was



FIGS. 11-17—TYPES OF WATER-CONTROL TANKS FOR MIXERS

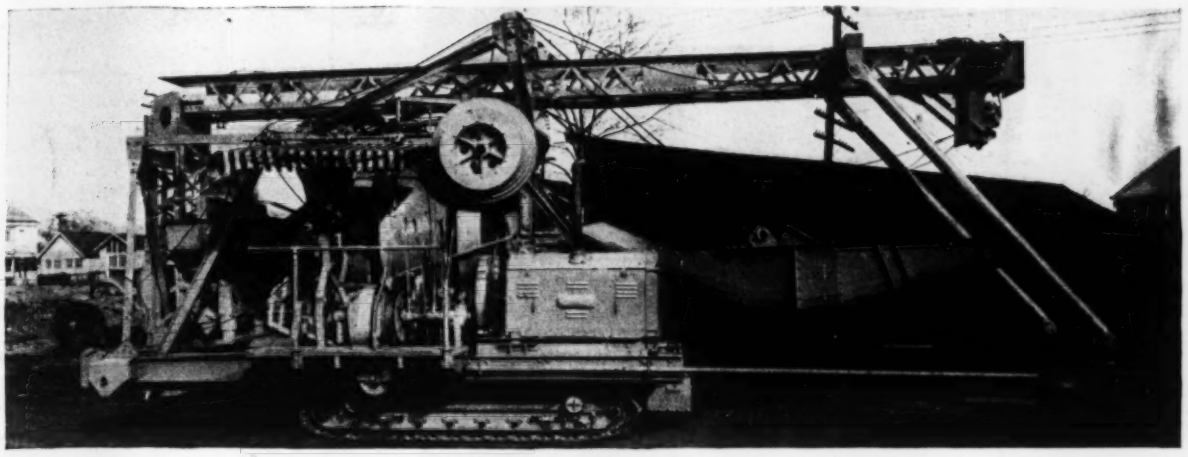


FIG. 18—EXAMPLE OF MODERN SPECIAL MIXER OUTFIT

replaced by the bucket with crosswise opening doors, after which came the present single-door, crosswise opening. The size of the paving mixer has gradually increased until the 27E is now the big seller.

Mechanical design of the paver has shown marked improvement. The early wheel machines have given place to the crawler traction. Automatic features of operation have developed gradually, such as automatic clutch knockout when the skip reached its maximum elevation; power discharge so arranged that the touch of a lever serves to swing the discharge chute to the desired position; automatic limit to the travel of the boom bucket and automatic timing of the mixing period so arranged that the batch cannot be discharged until the predetermined time has elapsed.

In January, 1928, at the Cleveland Road Show, one company introduced the mechanical man, a device to interlock automatically several of the successive operations. At the 1929 Road Show two others of the five paver manufacturers featured automatic control. The operator starts the chain belt cycle by swinging the discharge chute to discharge position, then the mechanism engages the skip hoist clutch, swings out the discharge chute as the skip begins to charge the drum, turns on the water supply and turns it off again after time has elapsed to permit the required tank discharge.

Power boom swing was a feature of the last Road Show, three of the five manufacturers showing it. Together with these mechanical improvements in operation, which have reduced the time batch to batch for any given mixing time until any further reduction seems to border on the impossible, has gone an improvement and refinement in general construction so that the present machine is a very reliable piece of equipment which performs for the contractor with a minimum loss due to breakdowns such as were common a few years ago. Some manufacturers are changing to as much inclosed transmission, equipped with ball and roller bearings, as can be worked into their designs. The aim is to produce more reliable equipment. No one as yet has inclosed the final drive to the drum, but even this will probably be done in the near future.

The paver has proved to be a unit which it is possible to modify into a flexible general-construction tool. Two of the manufacturers have equipped the 27E with a tower and hoist bucket to feed a line of chutes, the unit being able to travel around under its own power. A paver equipped with an inclined boom which could elevate to 45 deg. has been used. Fig. 18 shows a 27E equipped with a mast hoist.

Water-Tank Development

The discussion of water tanks has been left for the close. The requirements of the water-cement ratio method of proportioning concrete mixes has necessitated improvement in existing devices and brought about the development of new ones. The average construction mixer is not a serious problem. The mixer usually stays as installed and the quantity of water needs little attention except to make correction for varying moisture in the aggregate. The paver presents an entirely different problem, and water control is receiving close attention from the various highway departments.

The tank for the central mixing plant must not only be accurate, so accurate as to permit the central mixing plant to prove that it can furnish a superior product, but it must be quickly adjustable, because the central plant may change its setting for almost every consecutive batch.

The acceptable tank, therefore, must have convenient adjustment, and should discharge all of its measured quantity quickly, with freedom from a slow dribble to secure the last few quarts. It should be equipped with a valve arrangement which does not permit bypassing from the supply line directly to the drum. Some types of tank design are as follows:

1. Changing the position of a siphon tube to draw off more or less water (Fig. 11).

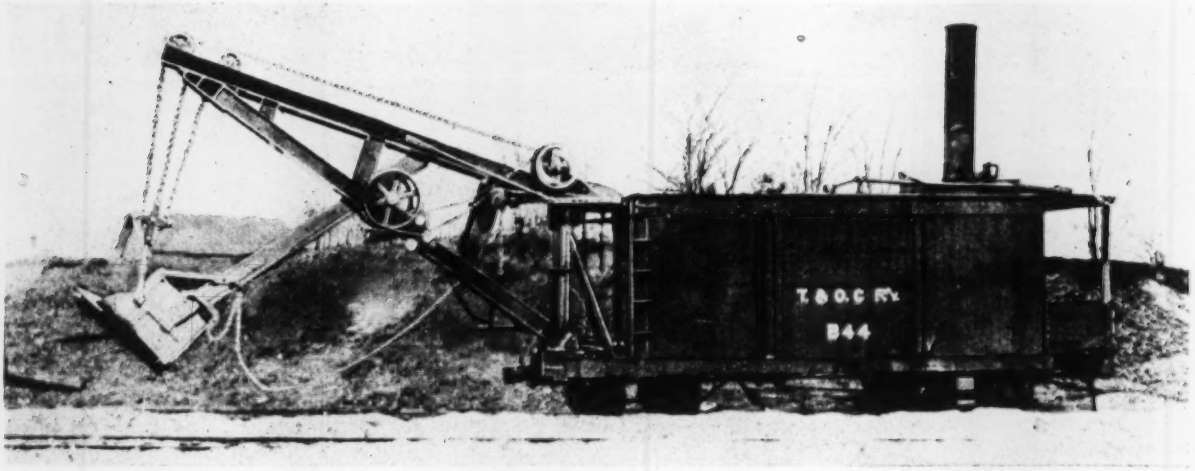
2. Using a fixed siphon tube and a displacement plunger to vary the quantity discharged (Fig. 12).

3. Using a fixed siphon for discharging and an auxiliary siphon or other means to admit air to the main siphon when the desired quantity of water has discharged (Figs. 13 and 14).

4. Using a vertically adjustable draw-off tube, discharging all water down to the level of the top of the tube (Figs. 15 and 16).

5. Using a tilting tank from which water is poured as from a pitcher, an adjustable stop being provided to limit the tilt to suit the quantity of water desired (Fig. 17).

One type of non-bypassing valve arrangement, using a well-known lubricated plug type of valve, is combined with a tank of the type shown in Fig. 14.



Railroad Type Steam Shovel Built in 1882

Power Shovels Show Revolutionary Advance

Invented in America in 1837—Big Development With Railroad and Canal Work After 1880—Working Radius, Mobility, Convertibility and Power Plants Advance Rapidly in Past Ten Years

By J. G. Miller

Manager Domestic Sales, Bucyrus-Erie Company, South Milwaukee, Wis.

THE development of power shovels is of particular interest to Americans, for the power shovel had its origin in the United States. There had been many mechanical devices for moving earth which antedated the power shovel. The earliest of these were probably floating machines or dredges; as early as 1513 Leonardo da Vinci sketched a machine for underwater digging and described its use. The first power shovel, however, was a steam shovel designed and patented by W. S. Otis and built in 1837 in Philadelphia. It was a machine with a single engine and a central mast upon which the boom, or crane, as it was then called, was swung. Mr. Otis never lived to see the popularity of his invention, but John Souther, who had worked with him, later manufactured the "Boston Shovel" in Boston, Mass. For many years he manufactured, with little change in design, a single-engine machine which carried a bucket varying in capacity from 1¼ to 2½ cu.yd. depending upon "the material it is to be operated in."

Early Heavy-Construction Period

The years immediately following 1880 ushered in an era of many projects which called for excavation in magnitudes to be accomplished only by the use of machinery. In February, 1881, work was started on the Panama Canal by Count de Lesseps' French company, and this huge project brought out many a machine remarkable in conception but impractical in design. During this period American railroad expansion began and the Chicago Drainage Canal was built. One of the great developments of the period was the introduction of the Thompson shovel with three separate engines, one for each motion—thrust, swing and hoist.

Following this, the mast shovel began to disappear and in its place came the A-frame shovel, which, instead of the older, triangular shaped crane, carried a straight boom resting on a swing circle at its lower end and supported by guys from a swivel on the A-frame, which replaced the mast.

Up until the last few years of the nineteenth century all shovels had the machinery mounted on a car body from one end of which the boom and dipper swung back and forth. Then came the first full revolving shovel in which all machinery, including the boom and its supports, was mounted on the revolving frame, which rotated on a base or truck frame. This machine had the obvious advantage of being able to swing through a complete circle, whereas the railroad shovel could swing at best a few degrees better than 180.

At this point it is well to note that, with the beginning of the twentieth century, the railroad shovel had gone

MODERN DIESEL ENGINE SHOVEL

through a great deal of development and was then being used in much more difficult digging that that for which the earlier machines were even considered. The full-revolving shovel, on the other hand, had just been introduced for the loading of ore at the ports of the Great Lakes. Thus it is quite natural that for many years these two types of shovels followed different lines of development, the small revolving shovel being constantly improved in mobility and speed, the railroad shovel in speed, strength and capacity. It was not until many years later that the advantages of both of these types were brought together in one machine.

Up to this time all shovels had been driven by steam power and although electric dredges had been built before this it was in the first years of this century that electric shovels made their appearance; similar to the first steam machines, these were driven by a single electric motor, but were followed a few years later by two-motor machines.

Modern Development Period

In the second decade of this century came many changes in the shovel industry: in 1911 the introduction of crawler mounting for small revolving shovels; in the same year a gasoline dragline, followed promptly by gasoline shovels. Shovel history was at this point when the World War began, and with the sudden cessation of labor influx from Europe to the United States came a greatly increasing demand for the small revolving shovel—one that could dig basements and sewers, do grading, highway work and shallow stripping. In the years that followed this type of machine forged ahead with remarkable speed.

Following the war have come several important developments, among which are the introduction of full diesel engine drive; the combination of the advantages of the full revolving shovel with those of the railroad shovel in the modern quarry and mining machine, and the increase in size of strippers to a dipper capacity of 16 cu.yd. The most remarkable change of recent years is the introduction of caterpillar traction type mounting for machines of all sizes, from the little fellow of ½-cu.yd. capacity to the big stripper whose bucket holds 16 cu.yd.

Types of Modern Shovels

Accordingly we find today that present power shovels may be divided into five groups:

1. Very small machines with dippers varying from ¼ to ½ cu.yd., some full revolving and some without full circle swing, almost without exception driven by gasoline engines and with working ranges limiting their practical use to the loading of trucks and some of them convertible to backfillers and draglines.

2. Full-revolving machines varying in size from ½- to 1½-cu.yd. capacity, built with the sturdiness necessary to do the hardest types of digging, available with several kinds of power; steam, gasoline, diesel, electric, gas + air, diesel + air, diesel-electric, and readily convertible for operation as dragline, clamshell, crane or drag shovel.

3. Quarry and mining shovels, built with all the ruggedness of the old railroad shovel and combining the advantages of the full-revolving shovels. These machines are built with either steam or electric drive and vary in capacity from 2 to 4 cu.yd.

4. Stripping shovels, full-revolving machines driven either by steam or electricity and varying in size from 2½- to 16-cu.yd. dipper capacity, designed to work in overburden up to as deep as 50 ft.

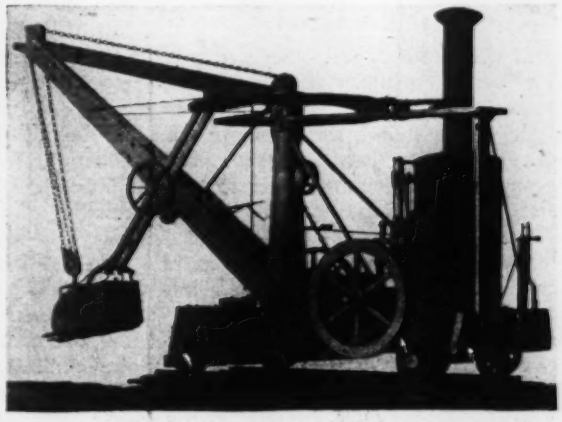
5. Special machines designed and built for uses where standard machines are not suitable—for example, subway shovels and tunnel shovels for the smaller sizes and horizontal crowd type coal-loading machines in the medium size.

Small Shovel Development

The first class, the smallest shovels, usually carries ¼-, ⅜- or ½-yd. dippers and their most noteworthy feature is their extreme mobility. They fill the need of the contractor who specializes in extremely small excavations, the contractor with whom the importance of moving rapidly from one job to another is very great. The machine with only approximately 180 deg. swing is under a considerable handicap when compared with the full-revolving machine, for it often brings great economy to be able to load the trucks behind the shovel instead of on one side of it, and even where trucks can be regularly loaded on the side, the convenience of being able to swing all the way around and lay oversize pieces behind the shovel will almost invariably justify the additional cost involved if any. Some of these machines are arranged to be more or less readily converted for use as backfillers; this, of course, is an added advantage for the man who has small sewer work to do. Little need be said about the type of power of these machines, for they are invariably driven by gasoline engines.

The second class of machines, the small full-revolving shovel with dipper capacity of ½ to 1½ cu.yd., with ruggedness and power to go into all but the heaviest kinds of digging, forms the largest class, in numbers, of the entire range of shovels today. These machines differ mainly from the smaller class in their more rugged construction and their greater working ranges, which permit the ready loading of trucks on the bank or the placing of overcast material well back out of the way. They find their uses in almost every branch of the excavating industry: basements, street excavation (including the grading of new roads and the removal of old surfaces for resurfacing), subdivision grading, sewer work, clay winning, small quarry excavation, gravel pits, logging railroads, small levee building, irrigation work and railroad maintenance. With these machines mobility is very important, and this feature has been developed within the past few years to a point that leaves little required by the average contractor.

Practically all of the earlier small machines were



OTIS STEAM SHOVEL BUILT IN 1837

MODERN ELECTRIC REVOLVING SHOVEL

mounted on traction wheels, which made it necessary for the shovel to work on mats most of the time. Today, however, practically all machines of this size are equipped with crawler-traction type mountings designed so that they can work on almost any kind of ground without the necessity of auxiliary mats, the bearing pressure of the mountings running, in the best designs, from 10 to 15 lb. per sq.in. Great advance has been made in building these mountings so that they are not subject to constant repair and so that they do not become clogged even when mired down or partly buried in loose material.

The wide range of work which is attempted today with these machines calls for greater convertibility than was formerly necessary. The manufacturers of excavating machinery have answered this demand by bringing out machines in which practically the only change necessary for operation as shovel, dragline, clamshell, crane or drag shovel is the substitution of front end equipment. For the contractor whose work is varied, it is important to be able to make these changes on the job without extensive alterations to the machinery.

The steam-driven shovels of these smaller sizes vary little among themselves in fundamental design. In the case of the machines driven by internal combustion engines, however, there is considerable difference found in the method by which crowding is accomplished.

The use of air stored during periods of the cycle when the motor is not otherwise called on for output of power has made it possible to produce an internal-combustion-engine shovel with a cycle very close to that of the steam shovel, the ideal cycle for the digging of rock and other hard material. Diesel-electric drive accomplishes this same object to a certain degree but raises the cost of the machine very appreciably.

Four kinds of power find general use today for machines of this size. The steam machine, the oldest of them all, has the ideal cycle for heavy digging. It has the disadvantage of smoke for city work and necessitates the hauling of considerable fuel and the maintenance of boilers. The gasoline machine eliminates boiler upkeep and requires a considerably lower volume of fuel. Heavy-duty gasoline engines have been developed by engine manufacturers to a point where they are very satisfactory for this type of work. The diesel engine has now been in use on this equipment for seven years and it has certain very distinct advantages over the gasoline machine, although its cost is somewhat higher. One of the most important advantages of the diesel engine is its extremely low fuel consumption. Burning only one-half to one-third the quantity of fuel required for a gasoline machine of the same size, it requires much less handling of fuel. As this fuel costs from one-third to one-quarter as much as gasoline, the contractor using the diesel engine is able to save a very considerable amount in his fuel cost. Furthermore, the cycle of the diesel engine is much better suited to power-shovel operation than is that of the gasoline engine. The diesel power "hangs on and pulls" better than the gasoline engine does. This is because instead of exploding, on the power stroke, a charge of fuel already in the cylinder, as is done in the gasoline engine, the fuel oil is sprayed into high-temperature, high-pressure air within the cylinder and burns as it enters. When the machine is under heavy load, this admission of fuel and steady burning continues for a large portion of the downward stroke, making smoother operation and a steadier supply of power. In addition to this, the speed of the diesel engine is usually slower than that of the gasoline engine, resulting in some advantage for the diesel engine in the matter of length of life.

Electricity is growing in favor as a type of power for these machines; one-motor shovels are used where it is desired to shake the dipper and three-motor machines where rock excavation is encountered.

A few years ago all small revolving shovels were built with structural base and structural revolving frame. Today the accepted design is one rugged steel casting for each of these units, doing away with maintenance cost and the tightening of rivets and eliminating deflection of machinery.

The use of ball bearings is increasing, and their use seems to be particularly desirable in the small machines. Today A-frames are lower than they were, resulting in machines of better clearances—machines that can be loaded on a flat car and moved from job to job without dismantling. Until recently almost all small revolving shovels were equipped with wooden houses. Today the steel house is constantly growing in favor.

A few years ago a dipper was a dipper; there was comparatively little variation in the design or the material used. Today dippers are made to exactly suit the work for which they are purchased and special steels are used for the different parts—steels that are particularly suited to resist the wearing action of the particular material in which they are used—refinements unheard of a few years ago.

In the early days one type of shovel had only one front end equipment, a standard length of boom and dipper handles. Today, each size of small revolving

shovel is designed for use with as many as three different lengths of booms and dipper handles. The dragline, to which it may be converted may have any one of three boom lengths and three bucket sizes, and the crane or clamshell is regularly equipped with any one of three boom lengths. The drag shovel of today is supplied with dippers of widths exactly suited to the width of trench to be dug.

Heavy Shovel Development

The third classification made above is headed "quarry and mining shovels." These divisions are not definitely outlined and cannot be, because many of the machines find wide application in different industries. In this class, for example, the smallest of these machines, the 2-yd., is practically as convertible as the small revolving machine used by the contractor. Furthermore, it is sold with several styles of power—steam, diesel or electric—and finds use as a shovel in heavy "contracting work," railroad construction and clay pits (where high faces are encountered and the shovel is called upon to mix the clay from the top with that from the bottom of the face). As a dragline the 2-yd. machine finds extensive use on irrigation and drainage work, gravel pits and levee construction.

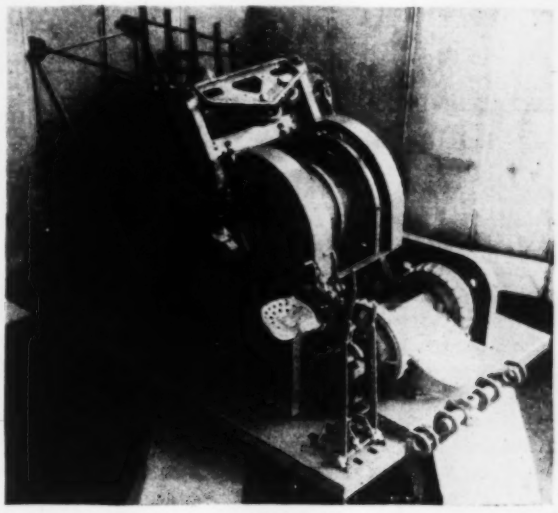
Taking the class as a unit, however, it is to be remembered that these are the machines that have replaced the railroad shovel and are built to stand the heavy rock work that the old railroad shovel was called upon to do. The design is marked by the use of huge, rugged, steel castings—one large casting for the base, either one or two castings for the revolving frame and markedly rugged machinery throughout.

Whereas the old railroad shovel is hoisted by means of a chain, the modern quarry shovel uses a steel cable.

Perhaps the most remarkable accomplishment in the design of machines of this type is the "close-coupled" design—the manner in which the builders have succeeded in putting the machinery into a small space and yet maintaining its accessibility. Close-coupled design of machinery reduces the rear end radius and makes it possible for the machines to operate in narrow cuts. Designed for a special purpose, the boom lengths are comparatively short, making for a fast swing. To appreciate this it is well to think of the revolving part of a shovel as a flywheel. As the inertia or flywheel effect is proportionate to the weight and to the square of the distance of the weight from the center of rotation, the inertia of the loaded dipper, boom and handle is sometimes as much as three-quarters of the total inertia of the whole revolving part of the machine, while the inertia of the ballast is a large part of the remainder. Thus the shorter front end and the resulting lighter counterbalance make a faster swinging machine.

With the present development of electric equipment for power shovels, it is not surprising that steam machines in these sizes are being used less and less. A glance at these modern electric shovels shows some very remarkable advantages which were not present with the earlier electrical shovels. The modern electric quarry shovel is equipped with Ward-Leonard multi-voltage control. With this type of control each motion is driven by an individual motor that is directly connected, electrically, to one of three generators. These three generators are driven by one large motor; the control is accomplished by varying the fields of each generator and motor. The resulting cycle is the closest to the "ideal" steam-shovel cycle that has yet been found. Since small currents only are handled in controlling the field of the generators, resistance losses within the machine are reduced to a minimum. Further, the design permits the regeneration of electric current by the drop of the dipper returning to the pit—regeneration which is in effect electric braking.

Stripping shovels, the fourth classification, are of comparatively minor interest to the construction industry, although they have been used to some extent upon big projects. They show, however, an advance comparable to the advance of the small shovel. A few years ago the 6- and 8-yd. shovels were the largest available; today



DIESEL POWER PLANT AND BASE PLATE

machines of 12- and 16-yd. capacity are in use. While somewhat deeper overburden is moved today than was moved a few years back, the main changes in design have been in the interests of moving more overburden at lower unit cost, making available for economic mining thin coal seams and seams of comparatively low-grade coal. This object has been obtained by producing strippers of 12- and 16-cu.yd. dipper capacity operating at the same speed as an 8-yd. machine, necessitating, of course, many unique features of design.

To the uninitiated it might seem very illogical for a coal mine to use an electrically operated machine, particularly when the generating station may be miles away. Closer study, however, shows that with the electrical machine the coal operator gets steady operation, cleaner coal, no boiler maintenance and a complete lack of reciprocating parts, which obviously need more repair than the revolving parts of an electrical motor. Another advantage of the electrical machine is its smoother, quiet operation; it is easier on the operator's nerves and he finds it easier to produce larger outputs. Many of these advantages are, of course, not limited to the electric stripping shovels but apply as well to smaller electric shovels. The fifth class of machines is a very important class, although it has no unity of size or type. The large shovel manufacturer is often called upon to design a new machine for special work or to adapt some standard machine exactly to suit some particular set of conditions. This always proves to be expensive work, bit it is often thus that new methods are introduced and new types of machines brought into general use.

Form Displacement Analyzed for Practical Concrete Workers

Part II—Vertical Displacement

Limits of Bed Sill Settlement—Compaction of Joints—Deflection —Wedging Hazards and Safeguards—Practical Wedging Practice— Amount of Camber Required—Curves for Computing Camber

By Ambrose G. Hampton

Resident Engineer, South Carolina State Highway Department McClellanville, S. C.

THE CONTROL of form settlement is usually most important where the horizontal lines of the span are prominent. The three usual causes of movement in the form for a concrete span are: (1) settlement of falsework foundation, (2) compacting of joints, and (3) deflection of members acting as beams.

Foundation Settlement—There are several methods of providing a foundation for falsework. In some cases the forms are carried on beams swung between substructures. The foundation settlement is then practically eliminated, but the proper treatment of beam deflection will be unusually important. In other cases the forms are carried on piles; the settlement will be negligible if the piles are driven to adequate capacities. When bed sills are used, however, a certain amount of settlement is to be expected, though its full effect is not easily estimated. It is true that wedges are often relied upon to take care of all unexpected displacement of the form, but for reasons to be explained later it is desirable to keep the amount of wedging to a minimum.

It is therefore advisable to have some idea of the settlement to expect from the various classes of bed sills. The following allowances based on actual observation are recommended: $\frac{1}{8}$ in. for best conditions, firm soil with good bearing of sills, and sills thoroughly tamped with sand or loose earth; $\frac{1}{4}$ in. for ordinary conditions and usual care in placing sills; $\frac{3}{8}$ in. or more for poor conditions, such as soft or lumpy soil, improper tamping or poor bearing of sills. The bearing area should always be enough so that the safe bearing capacity of the soil will not be exceeded.

Compaction of Joints—The compacting of joints is a considerable factor in form settlement, and as in the case of lateral displacement, its ultimate effect cannot be accurately calculated. The first step in reducing this cause of yield is to reduce the number of timber joints. All unnecessary shimming, blocking and wedging should be avoided and all bearing stresses perpendicular to the grain in timber should be kept down to a reasonable limit. In the collar tests it was found that the average joint of timber on timber yielded about $\frac{1}{8}$–$\frac{1}{4}$ in. for every 65 lb. per sq.in. of pressure. Until accurate tests can be made on the actual lumber used, this figure may serve to give an idea of what yield to expect from each joint.

In the case of one timber bearing with the grain (a post against its cap), it would seem that the yield should be about one-half as much, but this is not usually the case. It is true that the end-on timber will compress a negligible amount, but it must be remembered that it makes a good bearing only when sawed to a perfect fit. Even then it tends to cut into the other timber because of the alternate rings of soft and hard wood. Such a joint will therefore yield at least as much as where the timbers are both bearing against the grain and in the event of poor fitting may yield a great deal more.

Other causes of erratic settlement are: improperly fitting or undersized wedges, twisted or canted joists, timbers raised from supporting pieces by nailing, and poorly sized joints or stringers. Unfortunately there is no practical method of applying an initial pressure to a supporting form; otherwise some of these causes of settlement might be eliminated.

Deflection—The deflection of a member can usually be calculated fairly closely and its effect provided for. There are cases where the lack of a careful consideration of deflection will cause serious disfigurement of the structure. Suppose, for instance, that the entire weight of a span is carried by a number of beams swung between substructures and carrying cross-joists on which the beam bottoms are placed. Because of lack of space on the end supports it is difficult to place a beam directly beneath the concrete beam, and it is therefore swung inside as in the interior beams, which slopes the ends of the joists downward. The slope is increased by the deflection of the

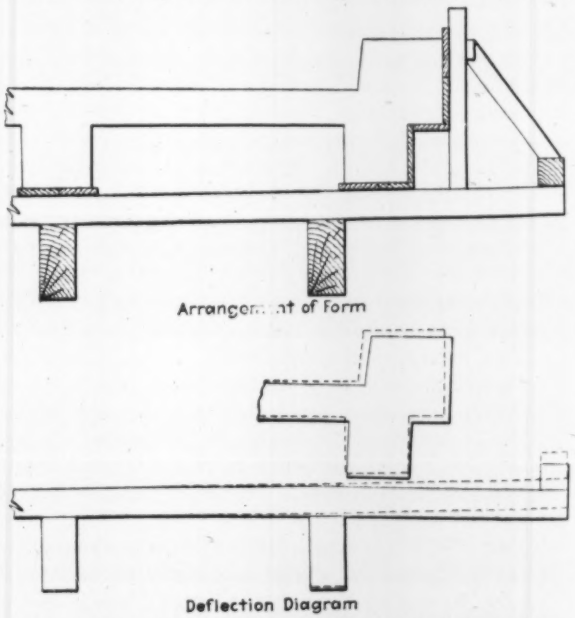


FIG. 5—EFFECT OF DEFLECTION ON FORM POSITION
Sketch indicating movement of curb form due to deflection of exterior beam and end of joist. Full lines show final position.

joists from the load on their overhanging ends. The result is a downward and outward movement of the curb as shown. This condition can be remedied by a proper spacing of the beams or by increasing the section of the outside beams so that their deflection will be about equal to that of the interior beams. The cross-joists should also be sufficiently stiff to keep the end deflection down to less than $\frac{1}{16}$ in. With any form of this type it is usually necessary to keep a careful check on deflections and to wedge up when necessary during the pouring.

Wedging Practice—Wedging is used both to bring a form accurately to position and also to keep it in position during pouring. A completed form should be wedged as little as possible, because it tends to cause a general distortion, often moving the sides out of line and raising stiff sections bodily when only a local movement is desired. A form so abused is almost sure to be badly displaced during pouring, as most of the weight is carried by the last wedges driven, the rest of the form being supported by the beam sides, which buckle under the weight of the concrete.

The amount of wedging needed during the pour should be kept to a minimum for two important reasons: (1)

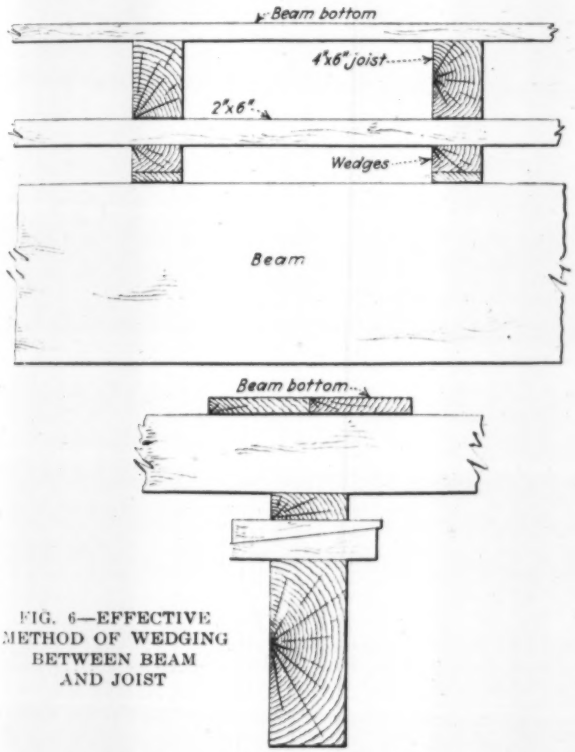


FIG. 6—EFFECTIVE METHOD OF WEDGING BETWEEN BEAM AND JOIST

because it may be neglected in the confusion or rush of concreting—all wedging should be done immediately after the concrete is placed so that the forms will not be disturbed during setting—and (2) because it is sometimes found that the wedges are incapable of moving the form and it is then too late to make other provisions. For these reasons it is well to estimate the amount of yield at every point and allow for it when the form is being built.

Wedges can be located in numerous places on a form and there are probably advocates for each location. Generally there should be enough wedges to carry the weight, they should be located at sufficient points to give the form the desired lines, and they should be located so that they are readily accessible and can be easily driven and released. Because of these considerations an arrangement is favored similar to that shown in Fig. 6, where the wedges are inserted between the stringer and a 2-in. piece which carries the joists.

The advantages of this method are numerous. Adjustment is provided at every point at which it may be needed, joists may be fastened to the strips to resist overturning, the wedges can be easily driven and can be released by prying with a bar between stringer and strip, the adjustment over each beam makes it possible to keep the joists in a horizontal position, and a sufficient number of wedges is provided to prevent the overloading of any

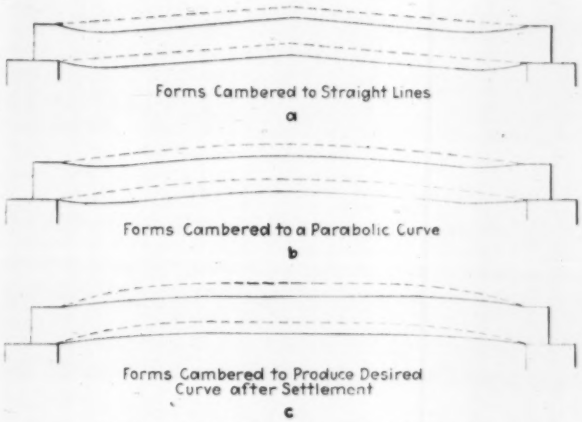


FIG. 7—EFFECT OF SETTLEMENT ON CAMBER OF FORM

one set. The chief disadvantage is the addition of another piece of lumber with another joint to develop yield. In this case, however, the bearing area is so large that the stresses will seldom exceed 50 lb. per sq.in., and as it is possible to secure a good fit at each joint, it is probable that the added displacement would not exceed $\frac{1}{64}$ in.

In order to avoid racking the form unduly but at the same time to get accurate results, it is best to do all preliminary adjustment after the beam bottoms are in place and before the sides are erected. The beam bottoms can easily be brought to the proper lines and should control the horizontal alignment of all other parts of the span. If the beam sides are built in long sections and act as spacers between beam floor and slab floor, they should be curved to conform to the expected camber of the form. As soon as the form has been brought to the correct position, the wedges or jacks should be secured against accidental movement.

Camber Important—Forms should be cambered to provide for the desired amount of camber in the finished span plus the estimated amount of displacement. The proper amount of camber for the various parts of a finished span is more or less a matter of individual taste and no attempt will be made to discuss it here. It will be assumed that for the short spans under consideration $\frac{1}{4}$ in. will be sufficient. The final lines of the span should, of course, be vertical curves and the form camber should be such as to produce these curves in the completed structure. In order to accomplish this the ordinate for the final curve should be figured for each point of adjustment and to this amount should be added the estimated amount of settlement that will take place at that particular point.

Where piles are used for falsework and the deflection of stringers is small, the settlement is usually about uniform for all joists except those very near the bents. Be-

cause of the stiff form sections resting on bents these points are usually relieved of a considerable part of their load. For these cases, therefore, the camber at practically any point on the form will be the ordinate of the final curve at that point plus a constant. Failure to introduce the form settlement as a constant for each point will result in the unsightly lines shown in *a* and *b*, Fig. 7. In *a* is shown the result of using the total camber at mid-span and building the form in straight lines to each bent. This method is often used by carpenters when left to their own resources. In *b* the form is cambered to a parabolic curve the middle ordinate of which is the correct camber at mid-span. This method is obviously wrong, as the allowance for settlement is introduced as a variable, and unless the displacement is very small it will result in an unsightly job.

Graph for Computing Camber—Fig. 8 gives suggested camber ordinates for four classes of forms. The settlement is assumed to be uniform for the central portion of the span but gradually diminishing within two-tenths span length of each support. If the ends of a form with bed sills are shored up from the footings, the end settlement will be considerably less, as shown by the dotted line.

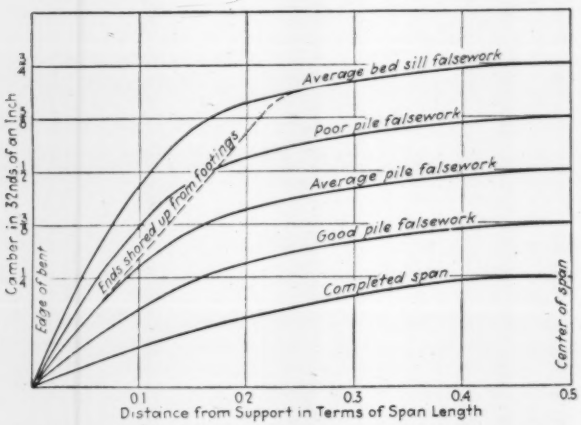


FIG. 8—GRAPH FOR DETERMINING CAMBER IN FORM
Based on approximately uniform settlement and a final camber in concrete of $\frac{1}{4}$ in.

The extent of this effect will, of course, vary with the length and stiffness of the stringers. The case illustrated is for stringers reaching only to the quarter point of the span.

To illustrate the use of the diagram, suppose that ordinates are desired for an average form with pile falsework. The span is 20 ft. clear with joists spaced 20 in. apart, so that the distance of each joist from the edge of the bent (exclusive of the one against it) in terms of span length is 0.083, 0.17, 0.25, 0.33, 0.42 and 0.5. If the camber is to be set by measuring down from a line stretched $\frac{3}{4}$ in. above bents, the desired ordinates may be obtained by reading from the $\frac{3}{4}$-in. horizontal line down to the proper curve. In this case they are as follows: $\frac{1}{2}$, $\frac{3}{8}$, $\frac{5}{16}$, $\frac{9}{32}$, $\frac{1}{4}$ and $\frac{1}{4}$ in.

It should be remembered that the curves are based on uniform settlement and that any feature of the form tending to produce uneven settlement will require special treatment. It is also evident that the point at which the settlement becomes uniform is approximately constant for all spans—depending more on the type of construction than on the span length—and that the 0.2 used in the diagram will ordinarily be too great for forms longer than about 25 ft. If the settlement is very slight, however, the curves can be safely used for spans 30 to 55 ft. in length.

Check Settlement During Pouring—Regardless of the care used in estimating and providing for settlement it is always advisable to keep a careful check on the form during pouring. This can be conveniently done by stretching a line along each beam side and marking its exact position at each joist. The allowable amount of settlement should then be laid off at each point and it is only necessary to see that this mark does not pass the line. It is important to watch the displacement at each joist as the concrete is being placed above it, because, as previously stated, the concrete should not be disturbed after it has obtained its initial set. The form should never be allowed to get badly out before being wedged up nor should it be wedged considerably above position with the assumption that it will settle back down. The settlement often stops very suddenly; therefore when a form once reaches its limit of displacement it should be kept as nearly as possible in that exact position.

If the job includes several spans of the same type, the behavior of the first one cannot be watched too closely, because any information thus gained means a saving of work and worry on all others. It should be remembered that no amount of calculating and estimating can take the place of a careful observation of form displacement under actual working conditions. If an unexpected movement occurs, it should be promptly investigated, in order that its cause may be discovered and its recurrence avoided.

Letters to the Editor

Paul M. Entenman—An Appreciation

Sir—The death of Paul M. Entenman at Banning, Calif., on March 29, at the age of 42 years, ends the career of one who but for ill health would undoubtedly have been one of the leading civil engineers of our country. I had the privilege of knowing him and enjoying his friendship since he was a young assistant engineer on the rapid transit subway construction in New York, full of enthusiasm for his work and ambitious to succeed, and I watched his development with much interest.

Nature was lavish in her gifts to him of those qualities of mind and character which inspire respect and make for success. He was a logical thinker who diligently sought truth and looked facts squarely in the face. He possessed ability of a high order with courage to follow the path pointed out by his clear vision. He clothed his thoughts in expressive language and had a forceful and delightful style of writing.

He and Clifford M. Holland were associated on the subway work in their earlier days, some twenty years ago, and formed a friendship that was close and unselfish and which endured until death. They had many traits in common. Both were ambitious to succeed in their chosen profession. Holland is credited with the generous statement that Entenman would have been the chief engineer of the Holland tunnel if his health had not failed some years before. In speaking of Holland one day Entenman told me that in their early years they had dreamed of becoming chief engineers and went on to say that Holland had lived his dream while he, Entenman, has been obliged to dream his life.

In 1914 he went to southern California on account of the state of his health and after recovering his strength sufficiently took up with his old-time energy work on irrigation and other problems peculiar and important to that section. Some six years ago he suffered a relapse and thereafter was confined to his home. He made a brave fight against his malady and if cheerfulness and courage could have prevailed he would have won. Even in his illness he did not lose active interest in his professional work. Some of the drawings he made while reclining on his couch would do credit to an expert draftsman. He had made a careful study of the Colo-

rado River problems and the Boulder Canyon project, of which he was a strong advocate, and few were better informed on the subject than he.

By his sterling qualities and his human understanding he attracted the friendship of many with whom the inspiration of his character will remain and to whom his passing is a very distinct personal loss. ROBERT RIDGWAY.

New York City,
April 1, 1929.

Steel Ties

Sir—In *Engineering News-Record* of Feb. 28, I note with much interest the editorial and the article on substitute railroad ties. I am confident that the age for wood crossties is about to pass and that this fundamental in railroad construction must be of steel or iron. The all-important principle in railroad maintenance is that of providing adequate foundation under the rails and a positive connection to the rail. When crossties are properly and securely locked to rail, they become self-ballasting, as, should they lift at all, small particles of ballast will fall under and the tendency will be to level an unequal space or tie.

A steel tie has been developed with a 15-in. bearing weighing 182 lb. and is shortly to be manufactured, being made complete for rail connection at one operation. It is designed from exact engineering formulas and can be placed in main-track line in renewals exactly in competition with wood. Insulation for the maintenance of signal service is now established as standard and corrosion does not enter into the argument of the life of steel ties. The London & Northwestern Railway, of England, has steel ties in active service after 44 years of use and the Duluth, Missabe & Northern Railway has steel ties which are in as good condition today as when placed eighteen years ago. CHARLES PAFF,

New York City, U. S. Metallic Cross Tie Company, Inc.
March 18, 1929.

[Experience alone can determine the practical and economic value of any substitute for wood ties. While Mr. Paff refers to design by engineering formulas, it must be remembered that the use of such formulas is to be governed by judgment and checked by experience. Thus, the concrete ties now being used by the Pennsylvania Railroad are said to have been "scientifically designed" but already show need of modification, as noted in *Engineering News-Record* of March 21, p. 478. The idea that loose ties will be self-ballasting by allowing ballast to slip under them is not supported by experience. A loose or "pumping" tie that rises and falls in the track tends to get more and more loose by crushing and displacing the ballast and allowing water to work in and make a soft spot. As to the English ties mentioned by Mr. Paff and noted in *Engineering News-Record* of March 7, p. 390, they are now obsolete and the few remaining are reported as being in unimportant yard tracks. General experience with steel ties in this country indicates that corrosion may be a definite factor in governing their life.—EDITOR.]

Combination Ties

Sir—The article on "Steel and Concrete Ties" in *Engineering News-Record* of Feb. 28, p. 345, does not present any tie with real practical, substantial and meritorious features that will permit of an elastic standard tie adjustable for new work or replacement where the rail flanges vary in width, or to take up slack in regaging worn rails, without drawing spikes or making readjustments in holes. Many designers think that the only way a rail can be fastened to a tie is to spike it down; others use bolt and clip, but neither of these will hold the tie in close contact with the rail at all times and under all conditions; hence friction and track creep, the latter being a large expense in upkeep of the track. The bolt and clip fastening is not adjustable for various rail flanges or for regaging purposes, and is not practical in replacing wornout wood ties and inserting substitute ties at intervals.

The Walker tie, composed of standard commercial shapes, is standardized to meet all classes of track construction without alteration; it will hold the tie in close contact with the rail at all times; it is adjustable to various rail flange widths, and will prevent track creep. It is readily adapted for switch-tie purposes.

Are railroads wanting a substitute tie? If so, what do they want? A steel tie that will last 100 years at the cost of a wood tie is an impossibility and an unreasonable demand. The evidence is that experiments have been made with various substitute ties for the past 35 years, some of which were freaks and some embodied good points, but none covered all the points required for good construction, simple design and adaptability in meeting the requirements.

The present cost of railroad track construction, using 130-lb. rails, creosoted wood ties, steel tie-plates, spikes and accessories to prevent track creep, will be from $22,000 to $25,000 per mile. The average life, based upon all kinds of wood ties used at present, is five years. A combination steel and concrete tie, along the lines of the Walker tie, using merchantable steel, will have a serviceable life of from 20 to 40 years. By using copperized or non-corrosive steel in stone ballast the life becomes interminable, so far as time service is concerned. The cost per mile of track in place would be around $25,000.

After the ties have become useless, the salvage in steel will amount to considerable and the concrete can be broken up for ballast. The comparison of costs is all in favor of the steel; life, strength, durability and time service, and salvage in the end. WALKER & MONG,

Somerset, Pa. Registered Architects.
March 18, 1929.

[In the article mentioned it was explained that only ties that have been in service were included. That substitute ties can be judged only from actual service is indicated by the large number of ties that have been tried in track and then modified, strengthened, redesigned or even abandoned as a result of their behavior. For many such designs the claims were similar to those made in the above letter. Bolted clip fastenings sometimes provide for varying widths of rail flange and also for adjusting gage on curves and for worn railheads. As to the average life of wood ties being only five years, that figure is much too low, while it cannot safely be predicted that any substitute tie will last 20 or 40 years. Treated wood ties have become satisfactory and economical as the result of years of study and experiment. It appears certain that the substitute tie must go through a similar period of development before it can compete with the treated wood tie. At present substitute ties are not on the market. If wanted, they must be made to order, and the purchaser is quite in the dark as to what service they will give.

Until much more is known as to the merits of substitute ties it cannot be expected that they will be used in more than a limited and experimental way. What is needed, therefore, is extended study, experiment and observation of substitute ties in railroad track, under the direction of competent and unbiased observers.—EDITOR.]

Lake Pleasant Dam

Sir—In the article on p. 275 of your issue of Feb. 14 on the Lake Pleasant dam you mention me among those who have reported on this dam. I should like to add that I was called in by the district in December, 1927, after the dam was completed, and therefore had nothing to do with the design.

When the dam is calculated by the older method, keeping the resultant inside certain limits and disregarding shear stresses, it appears from the check made by engineers prior to construction that the dam is safe. However, when checked on the assumption that the dam is an elastic structure and considering normal sections, as first advocated by me (*Trans.*, Am.Soc.C.E., 1924, "Stresses in Multiple-Arch Dams"), high tensile stresses are found.

The main defect of the design is the hollow buttresses adopted. This feature considerably augments the shear stress and the compression is not sufficient to prevent tension. The hollow buttress construction increases the ability to withstand buckling, but as I have shown in the paper referred to, there is no danger of buckling in multiple-arch dams as ordinarily designed. If solid buttresses had been used of same length as those built and of such thickness that the cost would equal the cost of the hollow buttresses as built, the dam would have been much safer and might have been safe with only a small reduction of the ultimate head.

I believe, as I stated in my report, that an attempt to patch up the dam by using reinforcing steel should be discouraged. It is easy to assume interaction between steel and concrete but not quite so easy to make sure that such an assumption is valid in the actual structure.

Los Angeles, Calif., B. F. JAKOBSEN,
March 22, 1929. Consulting Engineer.

News of the Week

Cables on Detroit River Suspension Bridge to Be Replaced

Decision Follows Order to Remove Mount Hope Bridge Cables Because of Wire Breakages—Same Wire Used in Both Bridges—Truss and Floor Beam Steel in Place at Detroit Must Be Taken Down

QUESTION as to the safety of the wire cables of the Ambassador suspension bridge across the Detroit River at Detroit, now under construction, led to the decision last week to remove the present cables and construct new ones. The extensive breaking of wires at the Mount Hope Bridge, whose cables are built of the same heat-treated wire as used at Detroit (see March 28, 1929, issue, p. 516) created alarm about the cables of the latter structure and led to stoppage of erection work a month ago. The decision to take down the Detroit cables now follows.

A statement announcing this decision, issued March 27 by Joseph A. Bower, president of the Detroit International Bridge Company, is printed below. It makes no reference to breakage of wires at Detroit, though, as reported last week, a number of breaks have occurred. Inquiry of Mr. Bower as to these breaks brought the reply that all information of a technical nature should come from the contractors, inasmuch as they were also the engineers. No information has been obtainable as yet from the contractors or the makers of the wire. From what is believed to be a reliable source it is learned that some breaks were found shortly after the spinning of the cable strands, and additional breaks were discovered during March, after erection work on the bridge had stopped.

J. A. Bower's Statement

The statement issued by Mr. Bower is as follows:

The McClintic-Marshall Company, Pittsburgh, Pa., the general contractor for the building of the Ambassador bridge, has decided to rebuild the cables because of the fact that due to certain physical characteristics recently developed in wire similar to the wire used in the cables of the Ambassador bridge the question has been raised as to the advisability of using these cables until further proof of the dependability of the wire has been obtained. In order to avoid delay and to eliminate all uncertainty the contractor has concluded to replace the cables with new cables.

Due to fortunate circumstances which permitted the contractor to advance the progress of this work, the delay caused by replacing the cables will not extend the completion of the bridge beyond the time specified in the contract for its delivery.

The contract for building the bridge provides, among other things, that the bridge shall be built satisfactory to Modjeski & Chase, our consulting engineers, and delivered ready for opening for traffic not later than August, 1930, and the contractor has given good and sufficient surety bonds for the performance of the contract.

The contractor's decision to rebuild the cables creates no additional cost to the company, as it is a matter which concerns the contractor alone.

I had hoped to open the bridge for traffic during the coming summer and give the public this facility for better transportation across the river, but this change in the contractor's plans will delay the opening several months.

Facts About Cables

The cables of the Detroit bridge were completed about Dec. 1 and work was under way on stiffening truss erection with about 25 per cent of the suspenders, floor beams and bottom chord in place when the order to halt work was issued. Because the structure has unloaded backstays the dismantling will involve only the main span steel and the cables.

The Ambassador bridge is a private toll structure connecting the city of Detroit with Windsor and the other border cities of Canada. It has a central span of 1,850 ft. and unloaded backstays. There are two cables, each consisting of 37 strands of 206 wires, No. 6, heat-treated and galvanized. In point of span it ranks second only to the Fort Lee bridge now under construction in New York City.

The original specification adopted for the cable wire was a duplicate of that used on the Philadelphia - Camden bridge. Before the contract was let, however, the specifications were amended to permit the heat-treated wire to compete with cold-drawn wire on the basis of a working stress for the former increased from 76,000 to 84,000 lb. per sq.in. The best offer received for wire in place contemplated the use of the heat-treated product, and this was subsequently approved.

No unusual troubles in handling the wire at Detroit have so far been made public. The method of spinning used was similar to that at Mount Hope, its unusual characteristic being the preforming of each wire at the strand shoe by bending it around a sheave with a diameter one-half that of the strand shoe.

The dismantling work will consist in cutting loose the stiffening truss, floor

(*Continued on p. 567*)

Detroit Voters Fail to Pass Rapid Transit Plan

The project for the construction of the first unit of a major rapid transit system for Detroit, Mich., failed to pass at the referendum held on April 1. About 70 per cent of the citizens voted against the proposition. Failure to obtain a favorable vote is believed to have been due to the lack of aggressive support by the press until too late to offset the campaign of opposition. Mayor Lodge has called for the submission of a new plan. The transit commission does not look for any material change in the financial details of the present plan in the new project. The principles of distribution of cost, partly through local benefit assessments, partly through general city taxes and through fares, is expected to be followed in the new plan.

Julian Hinds Goes to Los Angeles With Van Norman

Julian Hinds, of the U. S. Bureau of Reclamation, has been appointed chief designing engineer of the newly created department of water and power of Los Angeles, of which H. A. Van Norman is chief engineer and general manager, as announced in *Engineering News-Record*, March 21, p. 480.

Mr. Hinds is well known as a reclamation engineer, having served on the Yakima project in Washington and as designer of dam and plant for the Elephant Butte dam. In 1926 he went to Mexico as resident engineer for the J. G. White Engineering Corporation on the construction of the Calles dam and the Santiago irrigation project.

Right Sought to Build Tracks for Terminal at Los Angeles

The Los Angeles Terminal Exchange has applied to the Interstate Commerce Commission for authority to construct tracks, chiefly in subway, to connect all railroads now entering Los Angeles, Calif., with a union terminal, also to sell stock to finance the construction of the railroad and the purchase of land for the terminal. As soon as the construction of the railroad lines has been authorized, the company proposes to proceed with the purchase of land for the terminal. The proposed terminal railway will be electrically operated and will have connections with the Southern Pacific, Union Pacific, Santa Fe, and Pacific Electric Railway companies.

Steam Pollution Control Course Given by U.S.P.H. Service

An intensive course in stream pollution investigation and control was given to 21 state sanitary engineers by the U. S. Public Health Service at its Cincinnati Experiment Station, March 18 to 29, 1929. The course was provided in answer to a request from the Conference of State Sanitary Engineers that the exceptional training facilities at this experiment station be made available to the state engineers engaged in stream pollution control. A similar course given in May, 1928, to a group of the engineers of the Public Health Service demonstrated the value of the training.

In general, the men attending the course were the assistant sanitary enginers or chemists delegated to stream pollution work by the health departments of their respective states, rather than the chief sanitary engineers. The number was limited to 21 by the laboratory accommodations. The course was divided into laboratory work occupying three hours each morning, and lectures for three hours each afternoon.

Government Needs $398,000,000 in New Buildings

The interdepartmental committee appointed by Secretary Mellon and Postmaster General New report that to meet the demands of the entire country for public buildings an expenditure of $398,000,000 would be necessary. Congress has already authorized expenditure of $200,000,000 for buildings outside the District of Columbia and it is estimated that $48,160,000 will be available through the sale of obsolete buildings and sites at places where new construction is contemplated.

The report lists 571 projects, estimated to cost $247,800,000. Of these, 293 are new post office buildings in cities now without federal buildings. The other projects are distributed as follows: 100 to replace old or inadequate buildings, 16 additional at places now provided with federal buildings, 107 additions to existing buildings, 17 marine hospitals, and 38 border inspection stations for the customs and immigration service.

The distribution of the 571 projects shows every state represented, also Alaska, Hawaii, Porto Rico and the Virgin Islands. For the states alone, the projects amount to $246,124,000. In 1928 *Engineering News-Record* reported public buildings of all kinds to the value of $259,114,000.

N. Y. City Sanitary Commission Bill Dies in Legislature

The bill authorizing a department of sanitation for New York City, to have charge of sewage disposal and both the collection and disposal of garbage, ashes and refuse, noted in *Engineering News-Record*, March 21, 1929, pp. 449 and 480, failed to pass the legislature before adjournment, as did also the bill creating a city planning commission.

Charles E. Hughes Hears District on Lake Diversion

Testimony Also Given by General Jadwin and Colonel Schulz, Called by Hughes

FROM March 25 to 29 Charles Evans Hughes, special master appointed by the U. S. Supreme Court, heard testimony preliminary to drafting a decree relative to the matter of regulating the diversion of water from Lake Michigan by the Sanitary District of Chicago in accordance with the decision of the court adverse to the district rendered on Jan. 14. (See *Engineering News-Record*, Jan. 24, p. 146.)

In addition to the witnesses for the Chicago side of the controversy, Major Gen. Edgar Jadwin, Chief of Engineers, U. S. Army, and Col. Edward H. Schulz testified at the request of the master. Colonel Schulz indicated that the stipulations in the 1929 five-year permit, under which the Sanitary District of Chicago has been diverting 8,500 sec.-ft., had been lived up to by the district but that the city metering program was far behind. General Jadwin outlined the position of the army engineers with respect to the diversion necessary for navigation as follows: A reduction to 7,250 sec.-ft. after the completion of the plants expected to be finished this year; and an ultimate minimum of 5,000 sec.-ft., including the city's water supply. This amount is essential for the development of the Illinois waterway. For the Chicago River alone but 3,200 sec.-ft. ultimately would be needed. Reduction to 5,000 sec.-ft. will correct half the lowering of 6 in. and the remainder, in the opinion of the War Department, can be accomplished by lake-level regulating works at the lake outlets.

Testimony for the district was given by Langdon Pearse, the district's sanitary engineer, who summarized accomplishments to date and outlined a future program to collect and treat fully all of the sewage. This program would cost, according to an estimate made by the district and consulting engineers, $176,000,000 and take from twelve to fifteen years to complete. Harrison P. Eddy and John H. Gregory, consultants for the district, corroborated these figures. H. P. Ramey, asssitant chief engineer, brought the lake level hydrograph down to date, indicating that the lake is 1½ ft. higher than the average for this time of year for the last ten years.

At the close of the Chicago hearings the attorney for the Lake states indicated that complete cessation of all diversion will be claimed for the decree, meaning that the sewage and storm runoff must be returned to the lake.

The hearings will be continued in Washington beginning April 15, the Lake states putting on the first of their witnesses at that time.

Airport Contest Representatives Named by Commerce Department

The U. S. Department of Commerce has nominated Col. Harry H. Blee, chief of the airways and airport division of the Commerce Department, and Major Ernest Jones, aeronautical expert and editor of the department's official aeronautic bulletin, to be members of the program committee of the airport design contest being sponsored by the Lehigh Portland Cement Company. Other members of the program committee are George W. Lewis, director of the National Advisory Committee for Aeronautics; Paul Henderson, vice-president of the Transcontinental Air Transport, Inc.; Charles S. Jones, president of the Curtiss Flying Service; Porter Adams, chairman of the executive committee and past-president of the National Aeronautic Association; L. K. Bell, secretary of the Aeronautical Chamber of Commerce; Joyn Berry, manager of the Cleveland Municipal Airport; and Harry Schwarzschild, editor of *Airports*.

The Engineering Section is headed by Morris Knowles, of Pittsburgh, and includes Gavin Hadden, Francis Lee Stuart, Harold M. Lewis and Willard Chevalier. George B. Ford is chairman of the Civic and City Planning Section and other members are Fred C. McLaughlin, president of the New York State Conference of Mayors; E. P. Goodrich, Harold Buttenheim and Samuel C. Wetherill, Jr., president of the Regional Planning Federation of the Philadelphia Tri-State District.

Similiar contests have been held in Germany, France and Great Britain, according to William P. MacCracken, Jr., Assistant Secretary of Commerce for Aeronautics, but this is the first to be held in the United States. The contest will run until Nov. 18.

Plan to Improve Traffic Conditions in Toronto

A report by the Advisory City Planning Commission of Toronto, Ont., recommends expenditures in the downtown area aggregating $13,000,000 to improve traffic conditions. The report visualizes the traffic and building requirements of Toronto for the next 40 or 50 years and advances plans designed to create a downtown area that will be beautiful and at the same time free of traffic problems.

Railroad Proposed From Oregon Through Idaho Into Nevada

An application for authority to construct a railroad line from Myssa, Ore., through Idaho to Winnenecca, Nev., a distance of 238.7 miles, has been made to the Interstate Commerce Commission by the Idaho Pacific Railway Company of New York. The company is a newly organized one and plans to open up territories in Idaho and Oregon to more direct connection with the markets of California.

Special and Annual Meetings of N.E.W.W. Association

The annual meeting of the New England Water Works Association will be held at Portland, Me., beginning Sept. 17, 1929. An all-day meeting of the association will be held at Waterbury, Conn., on April 10. An inspection trip to the Shepaug water-works tunnel will be led by R. A. Cairns, city engineer of Waterbury, starting from Hotel Elton at 9 a.m. After luncheon at the hotel Mr. Cairns will talk on the tunnel and there will be three papers on meters, taking up maintenance and testing and the installation of Venturi meters.

Subway Urged as San Francisco Traffic Problem Solution

Rapidly increasing traffic congestion on Market St., San Francisco, has resulted in renewed activity of the press and civic organizations urging a subway for street-car traffic through the business district. After a three years' study of the traffic problem, Dr. Miller McClintock, director of the San Francisco traffic survey committee, finds that the only way to secure permanent traffic relief and avoid the threatening abnormal decentralization of the business center is in providing such a subway. The Market St. traffic problem, with its four street-car lines operating under two competing managements and the irregular, diagonal street intersections, has been declared one of the most difficult in the country.

A step toward the solution of the problem now under way is the installation of a complete system of pedestrian traffic control which will be ready for operation in about six months. Meanwhile, interest is being renewed in the possibility of clearing the street of car tracks by means of a subway. The proposition has received added impetus by the recent statement of Dr. McClintock to the effect that a subway is physically and financially possible and would provide transportation facilities for the business district among the best in the country.

Virginia Conference on Water and Sewage Treatment

A conference on operation of water-purification and sewage-treatment plants is to be held at Richmond, Va., on April 25 and 26, at which it is hoped that a permanent organization will be formed. Among the papers scheduled are: Treatment of New Gravity Water Supply at Staunton to Reduce Corrosion, by W. F. Day, city manager; Prechlorination and Filtration of Colored Waters at Norfolk, by W. W. Watkins, chemist, and at Newport News, by E. F. Dugger, general manager; the Blacksburg Sewage Treatment Plant, by Prof. R. B. H. Begg, Virginia Polytechnic Institute. Programs may be obtained from Richard Messer, chief engineer, Virginia Department of Health, Richmond, Va.

Engineers Needed for Public Buildings Program

The supervising architect, Treasury Department, needs a number of architectural, construction, mechanical and structural engineers for work in connection with the huge public buildings program upon which the government has embarked, the United States Civil Service Commission announces. Entrance salaries range from $2,600 to $3,200 a year. Higher-salaried positions are filled through promotion.

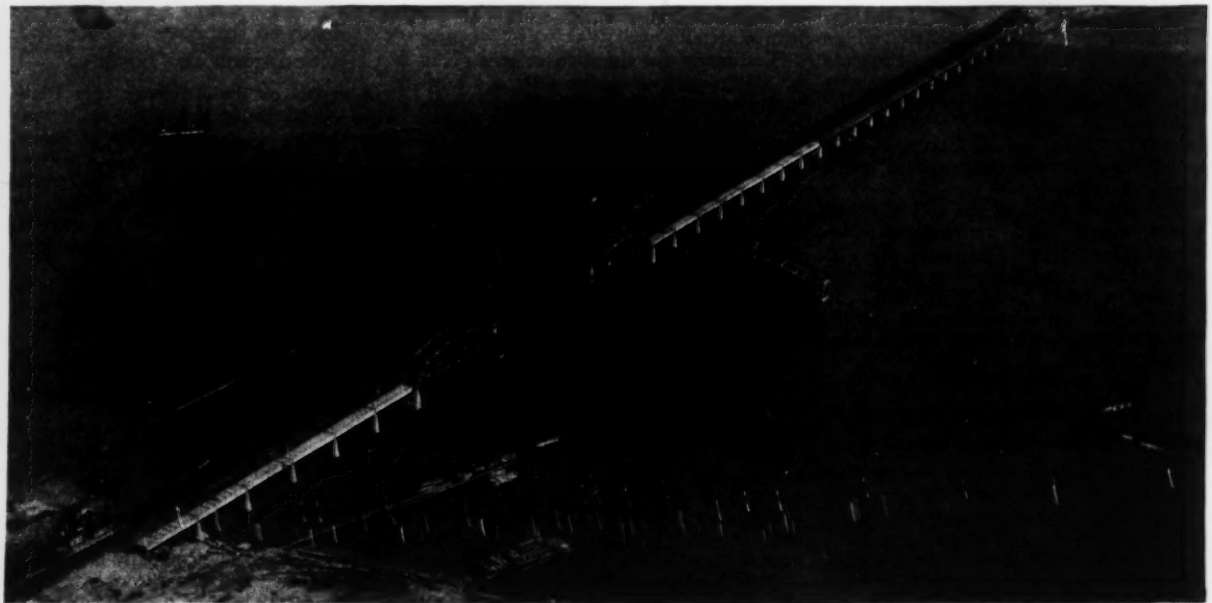
Applications will be accepted by the commission until April 24.

Next City Planning Conference Meets at Buffalo, N. Y.

The 21st annual meeting of the National Conference on City Planning will be held at Buffalo and Niagara Falls, N. Y., May 20 to 23. Topics already scheduled include "the new town of the motor age," exemplified by Radburn, N. J., and the Country Club District of Kansas City, Mo.; traffic analysis and forecast in relation to thoroughfare planning; street replanning in downtown districts of large cities; plotting control; regional planning—New York, Buffalo and Los Angeles; and city planning commissions. Town planning as a provincial function will be outlined by Horace L. Seymour, director of town planning for the Province of Alberta, Canada. Details of the program may be obtained from Flavell Shurtleff, secretary of the conference, 130 East 22d St., New York City.

New England Has Sewage-Works Association

The first meeting of New England Sewage Works Association will be held at Hotel Bond, Hartford, Conn., April 23, during the five-day meeting of the New England Health Conference. Papers will be read on sludge digestion, design and operation of tanks, sewage-works operation, the activated-sludge process and the value of records. Authors from outside New England will be C. A. Emerson, Jr., Philadelphia, and J. R. Downes, secretary of the New Jersey Sewage Works Association, Bound Brook. On Monday, April 22, several papers on water supply will be read before the New England Health Institute. Programs may be had from the Connecticut State Department of Health, 8 Washington St., Hartford.



Airview by Airmap Corporation of America, New York

NEW PENNSYLVANIA AND LEHIGH VALLEY RAILROAD BRIDGE OVER NEWARK BAY, N. J., SHOWING COMPLETED LIFT SPAN WHICH FELL FROM ITS FALSEWORK SUPPORTS DURING A WINDSTORM ON APRIL 1

Detroit River Suspension Bridge

(*Continued from p. 564*)

beam and suspender steel, lowering it to barges in the river and then removing the cables. This work will be confined to the center span, since the bridge has unloaded backstays.

The Detroit bridge is being built by the Detroit International Bridge Company, for which Modjeski & Chase are consulting engineers. The McClintic-Marshall Company is the designer and general contractor, with L. S. Moisseiff and Monsarrat & Pratley as its consulting engineers. The cables were erected by the Keystone State Corporation with wire furnished by the American Cable Company. An article on the general design of the bridge by Jonathan Jones, assistant chief engineer, McClintic-Marshall Company, appeared in *Engineering News-Record* Sept. 27, 1928. Other articles on various phases of the work have been published subsequently.

Dismantling of Mount Hope Bridge Under Way

Dismantling work on the Mount Hope suspension bridge near Bristol, R. I., was begun on March 25, the same day that the Mount Hope Bridge Company announced the decision of its engineers to condemn the cables that were in place on the nearly completed structure. Rivet heads are being chipped off and the rivets bucked out at a rapid rate preparatory to lowering the stiffening truss and floor steel to barges, on which it will be transported to storage near the Bristol anchorage. The tentative plan for removing the cables consists in flame cutting them a strand at a time into lengths about 30 ft. long which can be lowered to barges below.

An unusually rigid schedule of work has been drawn by the contractor in order to meet the tentative opening date of Nov. 15, 1929. No decision has been made public regarding the new wire to be used in the cables.

San Mateo-Hayward Bridge Across San Francisco Bay Opens

The San Mateo-Hayward bridge across the southern arm of San Francisco Bay was officially opened on March 2, fourteen months and fourteen days after the contract was signed. This 7.1-mile bridge, which is precast concrete trestle with the exception of five 300-ft. steel spans, was built by private capital as a highway toll bridge under the authority of a 50-year franchise from San Mateo County. Construction of this bridge was described in *Engineering News-Record*, Nov. 8, 1928, p. 686.

The toll for passenger automobiles is 50c. for car and driver, with a charge of 5c. for each additional passenger. Total cost of the project was about $7,500,000 and completion was 105 days ahead of the contract time.

Dedication ceremonies were followed by a toll-free period of approximately eight hours, terminating at midnight of the opening day. During this period it is estimated that more than 22,000 cars made use of the bridge. The maximum speed permitted at present is the state limit of 40 miles per hour.

This bridge is about 15 miles south of the Ferry Building in San Francisco and is the fourth to be completed recently tending to break the traffic barrier of San Francisco Bay. The others are the Dumbarton, about 8 miles farther south, and the Carquinez and Antioch bridges, on another arm of the bay.

Government Experiments With Soil Erosion and Terracing

Experiments with soil erosion and terracing are being conducted by the Department of Agriculture on a farm 4 miles south of Guthrie, Okla., and will be studied from an engineering standpoint. Measurements of intense rainfalls will be measured by means of self-recording rain gages. The run-off will be measured with the improved Venturi flume, the depth of flow to be recorded by water-stage recorders capable of recording time to the nearest minute and stage to the nearest 0.01 ft. The proper spacing of terraces, the grade, length and cross-section of terrace channels for different land slopes and soil types are factors that will be investigated.

The experiments, the first of their kind, are in charge of C. E. Ramser, senior drainage engineer.

WASHINGTON NOTES

By Paul Wooton

Washington Correspondent

Better Relations Between Corps of Engineers and Contractors—Work on Mississippi Is Delayed by Floods

ESTABLISHMENT of better relations between the Corps of Engineers and the Associated General Contractors was cited by Major Gen. Edgar Jadwin as one of the accomplishments of the year, in the course of remarks at the annual dinner of the corps March 30. Under President Garber, friendly relations have been established, he declared, with prospects favoring closer co-operation between army engineers and outside contractors. General Jadwin stated that the contractors are well satisfied with the proportion of the work on the Mississippi River that has been awarded them. Comment on the address at the offices of the Associated General Contractors was to the effect that they would feel better about the present situation if the engineers had not seen fit to erect a $2,000,000 concrete plant and were less active in the remodeling of their levee-building machines.

General Jadwin laid particular emphasis on the danger that he sees in that movements to construct bridges between major harbors and the sea. He mentioned specifically the proposed bridges at San Francisco and at Wilmington. Because of the powerful influence possessed by those who would profit financially in the construction of such structures and by those whose convenience would be served, it is becoming very difficult to prevent these restrictions on commerce, he declared. He admitted that he was all but overridden by the Congressional committee in the two instances mentioned.

Mississippi Flood Control

Threatened litigation in the areas to be traversed by the proposed floodways along the lower Mississippi apparently will not greatly delay the work there. General Jadwin pointed out that when these cases reach a certain stage in court, it then will be possible to go forward with the work, leaving actual settlement to be made later.

Bad weather and an unfavorable stage of the river retarded construction work on the Mississippi during February, when only 1,771,319 cu.yd. of earth was placed in the levees. This falls decidedly below the monthly average, as 19,417,796 cu.yd. was placed between July 1 and February 1. Of the total work done during the month. 1,478,048 cu.yd. was handled under contract and 284,271 cu.yd by hired labor. In addition 111,336 cu.yd. of spoil blank was handled. During February 19,711 squares of revetment were put in place, which falls materially below the monthly average of more than 50,000 squares.

Unemployment Insurance Advocated

While recognizing the good results that would follow the enactment of legislation speeding up public work activities during periods of depression, the U. S. Department of Labor believes that the real solution to the problem of industrial employment is unemployment insurance. Economic experts of the Labor Department fully realize that any type of governmental unemployment insurance would be repugnant to American industry. Such steps are unnecessary, however, since insurance companies have been manifesting increasing interest in the situation.

One of the largest insurance companies in the country has made overtures to the department sounding out its attitude. The only serious remaining obstacle is the lack of reliable unemployment statistics, it is declared. While the statistical department of the Labor Bureau has accumulated figures on employment trends among the various industries, there is at present no basis on which to apply these figures. Such a basis, it is said, would be afforded by a census of the unemployed. A movement is afoot to include authorization for an unemployment census in the regular census bill that probably will be passed during the approaching special session.

Personal Notes

W. M. HALL, previously employed as a general superintendent of construction by the U.G.I. Contracting Company, of Philadelphia, Pa., is now a general superintendent of construction with the Electric Bond & Share Company, of New York, in charge of the construction of a hydro-electric development inland from Bahia, Brazil, South America.

ALDEN C. FENSEL, who was until recently director of the Municipal Research Bureau of Cleveland, Ohio, is now associated with J. L. Jacobs & Company, management engineers and accountants, at Chicago.

D. W. LEGGETT, of Jefferson, Ohio, has been appointed division engineer in the state highway department in charge of the district consisting of Ashtabula, Columbiana, Trumbull, Portage, Summit, Mahoning, Lake and Geauga counties.

R. H. ANDERSON, formerly hydraulic engineer for the Tennessee Electric Power Company at Chattanooga, Tenn., is now construction superintendent for Stevens & Wood, Inc., on the construction of a dam and hydro-electric plant near Blue Ridge, Ga.

Major JOHN F. CONKLIN has been appointed by the War Department as district engineer, with headquarters at Nashville, Tenn. He will take the place of Major LEWIS H. WATKINS, Chattanooga, who has been temporarily released. During Major Watkins' temporary absence Major Conklin will have charge of the Chattanooga and Nashville areas, the former including Muscle Shoals.

JUNIUS W. JOHNSON, who has been district engineer in charge of the United States Bureau of Public Roads, with headquarters in Denver, Colo., since 1921, has been transferred to Washington. A. E. PALEN, who has been assistant to Mr. Johnson, has been named acting district engineer.

ALFRED H. FLETCHER, for the past four years assistant state sanitary engineer of Louisiana, specializing in malaria-control work, has been appointed sanitary engineer for the department of health, city of Memphis, and will be director of the bureau of sanitation.

Prof. ALLEN P. RICHMOND, JR., has resigned as assistant professor of civil engineering on the faculty of the Thayer School of Civil Engineering, Dartmouth College, his resignation to take effect in June. Professor Richmond has been connected with the Thayer School since 1920.

R. R. NUNN, construction engineer, of El Paso, Tex., is spending several months in Woodstock, Va., where he has contracted to design and erect a modern concentrating plant for the Hy-Grade Manganese Production & Sales Corporation. Mr. Nunn has recently completed plans for a new surface plant and transportation system for the San Francisco mines in Mexico, near Parral.

JAMES B. GIRAND, consulting engineer, of Phoenix, Ariz., recently left for Chile to act as consulting engineer for the Chilean government in connection with proposed power and irrigation projects. The work will consist of investigating and preparing plans for the reclaiming of several hundred thousand acres of arid land in that nation. Mr. Girand plans to be in Chile for about a year.

R. C. HARDMAN has recently been appointed director general of highways by the government of Costa Rica, to have charge of the new highway program being inaugurated by that country. Mr. Hardman's highway experience has been gained as district engineer, Bureau of Public Works, Philippine Islands; municipal engineer of the Panama Canal, assistant chief engineer of the Central Highway Board of Panama and chief engineer of the national highways of Salvador.

Engineering Societies

CALENDAR

ANNUAL MEETINGS

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; spring meeting, Dallas, Tex., April 24-26.

AMERICAN WELDING SOCIETY, New York; annual meeting, New York City, April 24-26.

AMERICAN ROAD BUILDERS' ASSOCIATION, Washington, D. C.; annual meeting, Washington, May 2 and 3.

NATIONAL FIRE PROTECTION ASSOCIATION, Boston; annual convention, Memphis, Tenn., May 13-16.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia, Pa.; annual meeting, Atlantic City, N. J., June 24-28.

AMERICAN WATER WORKS ASSOCIATION, New York; annual meeting, Toronto, Canada, June 24-28.

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; annual meeting, Mexico City, Aug. 26-28.

* * *

THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS will meet in Dallas, Tex., June 24 to 29. This will be the first Southern meeting of the organization.

THE WESTERN SOCIETY OF ENGINEERS has the following nominations for officers for 1929-30: president, William S. Monroe; vice-presidents, D. J. Brumley, W. O. Kurtz and Frank D. Chase; treasurer, Leigh S. Keith; trustee, Charles V. Weston.

THE AMERICAN ROAD BUILDERS' ASSOCIATION will hold its annual meeting in Washington, D. C., May 2 and 3. The officers and directors elected at the recent convention in Cleveland will be installed at this meeting. At the same time the regular annual meeting of the city officials' division and of the county highway officials' division will be held.

THE STRUCTURAL ENGINEERS SOCIETY OF NEW YORK, at its annual meeting March 26, elected the following officers for the ensuing year: president, L. A. Ball; first vice-president, N. A. Richards; second vice-president, A. Van Vleck; secretary, H. H. Snyder; treasurer, H. R. Burroughs.

Obituary

JOHN S. MUCKLE, of Philadelphia, died on March 20. He was 67 years old. Mr. Muckle played a large part in the designing of Philadelphia's high-pressure pumping service.

PAUL M. ENTENMAN, for a number of years an engineer on the construction of subways in New York City, died at Banning, Calif., on March 29, following a long illness. Mr. Entenman was born in New York City 42 years ago.

W. C. LEWIS, consulting engineer, Dallas, Tex., died at his home there on March 28, following a few days' illness. Mr. Lewis was 60 years old, a native of Fredericksburg, Tex. He specialized in building construction, having acted as a consulting engineer on a number of large buildings, including Wanamaker's store in New York and the Federal Reserve Bank in Cleveland.

JOHN L. MCGRANE, county engineer of Pottawattamie County, Iowa, died on March 23. Mr. McGrane was born in Rochester, N. Y., in 1892. After fourteen months' service in the World War, he went West and was, at different times, connected with both the Missouri and Iowa state highway commissions as resident engineer. He served as county engineer in several Iowa counties. He was a member of the American Society of Civil Engineers.

GEORGE H. FLINN, chairman of the board of Booth & Flinn, Ltd., of New York, died of pneumonia on March 29 in a Pittsburgh hospital. Booth & Flinn, Ltd., completed many large engineering projects, including the Liberty tunnels, Pittsburgh; the Fourteenth St., the Montague St. and the Clark St. tunnels, New York City; the Holland tunnels, New York to New Jersey; several large aqueduct contracts, including the crossing of the Harlem River; several sections of the Passaic Valley sewer through the city of Newark; the Bates St. sewer and several other contracts in the cities of Detroit and Toledo; numerous pipe lines through the West and Southwest, including a line from Tulsa, Okla., to Chicago, a distance of 800 miles, also a line from Pampa to Wichita. The George H. Flinn Corporation, of which Mr. Flinn was president, recently completed a section of the Eighth Ave. subway in New York City and is well along on another section, including the crossing of the Harlem River.

Construction Equipment and Materials

Some New Motor Truck Bodies Developed for Concrete Haulage

NO SINGLE type of construction equipment in recent years has made its appearance on the market so rapidly or in such relatively large numbers for a new product as the special body for concrete haulage. In the present stage of development it is available in two distinct designs—the truck-mixer body and the ready-mixed concrete body. The distinction between these two types should be kept clearly in mind.

The principle of the truck-mixer body is based upon the practice of charging the aggregate and cement dry, and accurately measuring the water into a tank carried on the truck. Either en route to the job or at the job the water is turned into the body, and the concrete mixed, usually by the truck's motive power. Truck-mixer bodies are usually built as drums or cylinders of various lengths, although one body has a semi-circular cross-section with an open top. All the bodies contain mixing blades of various designs and arrangements.

The purpose of the ready-mixed concrete body is only to prevent segregation of concrete which has been mixed at a central plant and is being transported some distance to the job. These bodies are of more varied design than are the truck-mixer bodies, some of them utilizing revolving drums, whereas others resort to paddles or merely to a tumbling action of the concrete during dumping.

There are gathered together below descriptions of a number of these new bodies such as are being seen in increasing numbers.

Barrymore Truck Mixer

The truck mixer developed by the Barrymore Corporation, Union Trust Building, Cleveland, Ohio, is described as a combination open-top dump body and concrete mixer. It is built to fit the chassis of all standard motor trucks and is available in three sizes, 1, 1¾ and 2½ cu.yd. The water is carried in tanks along the sides of the body and mixing is accomplished by means of "plow-share" curved spade-like blades so spaced and overlapped, according to the manufacturer, as to cause a simultaneous triple action of (1) lifting and spreading of materials around the shaft to which the blades are attached, (2) rotating and churning of materials in a circle from end to center and back, and (3) surging up volcanically. An important point in regard to concrete mixed with the Barrymore truck mixer is that the aggregates are transported to the job dry, and arriving at the job are premixed dry for about one minute, when the necessary water is added and a further mix of two minutes is accorded the mass. Such a process is claimed by the manufacturers to result in a complete application of the cement paste to all parts of the aggregate.

The manufacturers believe that the open top allows the only quick, simple and easy way to load any body by the use of gravity from regular batchers. Another advantage of the open top is that cleaning is accomplished easily at the end of each day by merely turning a hose into the body. Also, the open-top body is available for hauling stone and sand, in which case its capacity is doubled. Power is furnished from the truck engine to a set of gears designed to allow the average engine to handle the load with ease. Discharging is controlled through a large swinging tail gate or a smaller adjustable strike-off gate.

Bartlett-Snow Ready-Mix Body

Two features of the ready-mix concrete body developed by the C. O. Bartlett & Snow Company, Cleveland, Ohio, which are stressed by the manufacturer are (1) that it conditions the mixed concrete and prevents segregation without resorting to mechanical agitation of any kind, and that (2) it is immediately adaptable for general haulage work.

The body, as shown in the accompanying illustration, is of the end-dump type and differs from other bodies in that the sides consist of movable plates. These sides are brought together at the bottom, forming a "V," and while in this troughed position receive the load of wet concrete. When the truck has arrived at its destination these movable sides are wound back to a vertical position by a crank located at the front end of the body. This movement of the plates causes the load to be spread over the entire bottom of the truck and any segregated fluid to mix with the mass. The body is then tilted and the mass flows toward the delivery end, with a further conditioning taking place in the churning at the end gates.

There are no mechanical baffles or obstructions of any kind within the body. This feature makes it suitable for additional duty, since with the sides in a vertical position it forms an ordinary rectangular end-dump body. The body shown in the illustration is mounted on a special high-lift hoist which adds to the distance that the concrete may be chuted direct from the body.

Blaw-Knox Agitator Body

In the ready-mixed concrete body invented by Graham Brothers, contractors and ready-mixed concrete dealers, of Richmond, Va., and now manufactured and sold by the Blaw-Knox Company, Pittsburgh, Pa., the concrete is agitated by revolving blades which are geared to the truck transmission. According to the manufacturer, this agitation positively eliminates segregation and in fact improves the quality of the concrete. It is also stated that wet and dry mixes are handled with equal facility and that the agitating mechanism not only stirs in the circular cross-section of the concrete mass but keeps it in constant circulation along the length of the body.

The bodies are available in 1-, 2- and 3-cu.yd. sizes for hauling ready-mixed concrete, the same bodies being suitable for use in general haulage work of sand, gravel, coal, etc., under which circumstances their respective capacities are 2.75 cu.yd., 4.75 cu.yd. and 5 cu.yd.

It is said that these agitator bodies are available for and can be easily attached to any type or capacity of motor truck. In addition, any standard make of body hoist may be used. On the other hand, the company recommends the use of a high-lift hoist inasmuch as it provides sufficient vertical clearance to dump the load into a storage hopper on the job, thus releasing the truck immediately and saving truck time. Also the high-lift hoist permits longer chuting of the concrete.

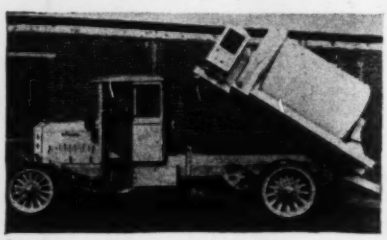
The agitating blades, which may be seen in the accompanying illustration, are set within ⅛ in. of the body itself. It is claimed that a patented design of the tooth which releases the coarse aggregate absolutely eliminates any binding or wedging of aggregate between the blades and the body. The agitating mechanism, which is connected to the truck transmission and is said to require only 4 hp. to operate, is mounted on a center shaft supported on three fixed bearings, the center bearing being of split design for easy adjustment. The mechanism is automatically disconnected from the truck body when hoisting to dump and is automatically reconnected when the body is lowered. The agitators make 4 r.p.m. with the speed of the engine at 20 m.p.h.

If it is desired to use the truck for general haulage purposes, this may be done without removing the agitating mechanism, or this mechanism can be removed in about twenty minutes by taking off sixteen bolts. Another important feature of the body is that the discharge of concrete can be controlled by means of the rack-and-pinion gate, clearly shown in the accompanying illustration.

Clinton Revolving Bodies

The revolving bodies for hauling ready-mixed concrete developed by the Clinton Motors Corporation, Reading, Pa., are claimed by their manufacturer to be scientifically correct and in addition to number strength and simplicity among their dominant features.

The body consists of a cylindrical steel tank, the inside walls and ends of which are perfectly smooth with no obstructions of any kind. Loading is accomplished through a door in the top large enough to take the full mixer charge without spillage. After loading, the tank is hermetically sealed and slowly revolved until ready for discharge. This rolling action is claimed to eliminate all segregation and to cause more complete hydration. The body is discharged from the rear by elevating its front end. The discharge door opens quickly by means of a 30-in., ratchet extension handle to a full opening of 10x23 in.

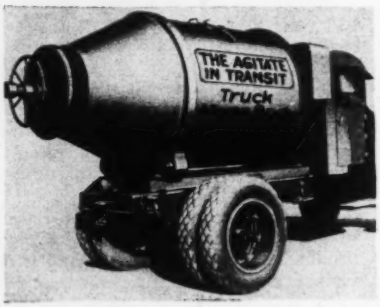


The body is supported at each end by large trunnion shafts revolving in self-aligning roller bearings. The body is revolved through a cut steel pinion engaging with a gear attached to the outer circumference of the tank at the front end. Power for revolving the tank is furnished by an independent two-cylinder, 8-hp. engine, operating at a predetermined speed. The power is transmitted by a sprocket on the gear shaft through chain drive to a corresponding sprocket located on the pinion shaft.

The 2-yd. capacity body is available for light, fast delivery—for example, on new subgrades or where the going is too soft for heavy trucks. This unit is equipped with pneumatic tires. The 3-yd. units as used on the big jobs are equipped with solid tires, although large pneumatics are available if necessary.

The Jaeger Combination Body

The elimination of the expense and dead weight of a hoist is one of the principal advantages claimed for the Jaeger "Agitate" or "Mix in Transit" body developed by the Truck Mixer Company, 520 Dublin Ave., Columbus, Ohio. The body consists of a permanently cradled drum which rotates in one direction to charge and reverses rotation to discharge. The bodies are



built in 1-, 2- and 3-cu.yd. sizes and are said to be suitable both for mixing en route or for hauling ready-mixed concrete. The manufacturer also claims that the bodies are suitable for hauling gravel, sand or other bulk materials.

When installing the bodies they are merely clamped to the truck chassis, no drilled holes being necessary except on one or two makes of trucks. The standard automotive gear reductions are easily connected with the body. A feature of the design of the body is that the load is balanced and carried well forward of the rear axle and between the tires with a low center of gravity.

In charging ready-mixed concrete or ordinary bulk materials the body can be loaded through a manhole fitted with a removable watertight door. For truck-mixed concrete, however, the load of dry materials is charged from the end and the screw action of the blades carries the load forward into the mixing chamber. The high screw blades in the cone prevent the load coming out while mixing en route. The discharge action is of the screw type and discharge is accomplished merely by throwing the reverse lever. The manufacturers claim a dumping time of from 18 to 40 seconds depending on the size of the load and the consistency of the mix.

Bodies are made in 1-, 2- and 3-cu.yd. capacities. The 1-cu.yd. body is suitable for such light trucks as Fords, Chevrolets, etc. The 2-yd. body, which can carry 3-cu.yd. of premixed concrete, is suitable for 3- to 4-ton trucks of the short-coupled type, while the 3-cu.yd. body is suitable for large commercial concrete companies operating 5- and 7-ton trucks. The latter has a premixed concrete capacity of 4 cu.yd. Special 5-cu.yd. premixed bodies can be furnished if desired.

LeBlond-Schacht Agitator Body

The special unit for hauling ready-mixed concrete developed by the Avril Tru-Batch Concrete Company, Cincinnati, Ohio, in collaboration with the LeBlond-Schacht Truck Company, also of Cincinnati, Ohio, consists of a revolving drum of 2-cu.yd. capacity mounted on a special 2½-ton truck with a wheelbase of 126 in. This short wheelbase is claimed to contribute greatly to a saving in truck running time, because of the consequent ease of maneuverability at the mixing plant and at the job.

A special characteristic of the body is that it is mounted transversely on the truck chassis, affording a direct chain drive from a sprocket wheel on its mounting shaft to another sprocket on a worm speed-reducing unit. A specially designed ball-bearing-equipped transmission power take-off is used whose speed can be varied to meet different requirements. The body itself rotates on special self-aligning S.K.F. roller bearings and can be operated independently of the truck.

The body, in the form of a rotating cylinder, is filled and emptied through a watertight door operated by a gear-and-ratchet mechanism with a hand crank. No vanes or paddles of any kind are used in the rotating cylinder. The capacity of the body is 2 cu.yd. when loaded about two-thirds full. It is said to be necessary to leave the remaining space open to assure agitation of the concrete as the body revolves; completely filling the body would result in

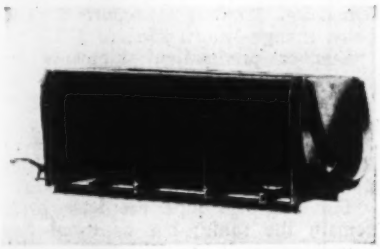
movement of the concrete as one solid mass.

Advantages claimed for this agitator body are that it is unusually simple in design, of light weight, and of rugged construction. Also, the load is always in the center of the chassis and no hoist is required for dumping. Concrete can be chuted 7 ft. to the rear of the truck on road jobs, according to the manufacturer.

The weight of the unit complete is 9,100 lb. (chassis 6,000 lb., body 3,100 lb.). The width of the body is 83½ in. and of the tank 64½ in. The tank has a diameter of 60 in. and the gate is 20x24 in. The truck is a Schacht model T with a wheelbase of 126 in., a speed of 30 m.p.h., a four-speed transmission, a 7-in. pressed-steel frame on 34x7 in. pneumatic tires (dual type on the rear) and a six-cylinder Waukesha engine with a bore of 3¾ in. and a stroke of 4½ in.

The Wood Bathtub Body

A bathtub type of body for ready-mixed concrete has been developed by the Wood Hydraulic Hoist & Body Company, Detroit, Mich. It is claimed that the semicircular bottom prevents

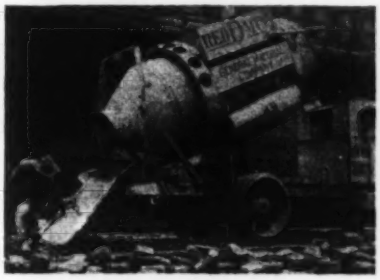


the wet mix from sticking, since an equal pressure is exerted downward and in from the curved sides. The front end of the bottom has a long slope instead of a true radius, which is said to break the vacuum and permit the material to fall away freely. The tailgate is made perfectly watertight and no sharp corners of any kind are utilized in the body, which is constructed of eight-gage, blue annealed sheet steel hot-riveted throughout. The body has extension sides so that when a one batch load is hauled the additional height of the sides and a 6-in. top flange which is turned in prevents the wet mix from spilling. The body may be mounted as a high-lift unit, permitting an increase in its chuting range. It may also be fitted with mixing apparatus or paddles for mixing or agitating in transit.

Paris Transit Mixer

A truck-mixer body developed by Transit Mixers, Inc., Call Building, San Francisco, Calif., and known as the Paris transit mixer utilizes a revolving drum and a blade arrangement which is claimed to produce a perfect homogeneous mix. This is said to be assisted by the loading method utilized, which consists in revolving the drum during the loading of the aggregate, thus assuring complete dry mixing. This is made possible by a special transmission which allows revolving the drum in either direction and at all positions, whether raised or lowered.

A tank of dual compartment type is used for the main and reserve water



supply. It is claimed that the water is distributed quickly, accurately and dependably throughout the aggregate. The revolving of the drum during discharge is also said to give either instantaneous or controlled discharge with no separation of aggregate. Mixing can be accomplished either in transit or at the job. The controlled discharge feature makes is possible to pour concrete into forms, buggies or hoppers direct from the mixer. The body is operated and hoisted to dump by means of the truck's motive power. A feature of this truck-mixer installation is that each truck carries a length of chute which can be pivoted at the rear of the chassis and swung from an A-frame, permitting discharge of concrete to the rear or to either side.

Hug "Redi-Mix" Body

The special body for handling wet concrete developed by the Hug Company, Highland, Ill., claims for its outstanding characteristics the instant release of the entire wet batch of material and the remixing of the concrete during dumping. Other features are simplicity of design and automatic operation. The body is furnished exclusively on its own

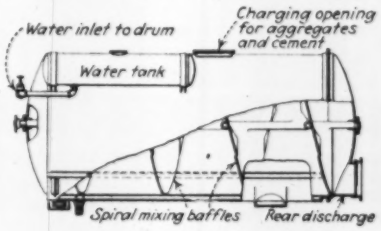
"roadbuilder" truck chassis in order to provide a well-balanced unit and to insure correctly designed equipment, according to the Hug Company. It is furnished in capacities of 1 and 2 cu.yd of wet concrete.

The body dumps from the rear by virtue of a toggle-arm arrangement whereby the upper part of the body shell leaves the lower portion of the body, the latter forming a chute for the release of the wet concrete as the body is being raised. This feature is shown in the accompanying illustration.

The remixing feature is accomplished by providing a baffle cross-division plate near the center of the body. Since the wet concrete leaves the body as the body begins to rise, the concrete slides out under the baffle cross-member, which is claimed to force the top water and cement down through the mass, precluding any possibility of the top of the load slushing off. Another feature of the body is that it permits the dumping of a partial load by regulating the separation of the two parts of the body.

Scott Transit Mixer

The truck-mixer body developed by the Smith-Hamburg-Scott Welding Company, Inc., Long Island City, New York, utilizes a spiral mixer arrangement of reversible baffles which is said to assure perfect mixing of the concrete, at the same time eliminating the necessity of a body hoist for dumping. The mixing is accomplished by revolving the spiral through a chain-drive power take-off from the truck transmission. When dumping the power take-off is placed in reverse and this forces the concrete out



into shunts for either side or rear delivery.

The body consists of a steel tank supported on a patented flexible truck mounting and equipped with the patented spiral. It is available in 2-, 3- and 4-cu.yd. sizes for mounting on a truck chassis of any make with capacities from 3½ up to 7 tons. An important characteristic of the body is that the motor exhaust furnishes heat for freezing-weather delivery. A water tank is attached to each side of the shell, one to furnish water for mixing while the other carries water to flush the drum on the return trip. Another advantage of the design of this body is that it is set low on the truck chassis to assure speedier driving safety as well as a clear rear view.

New Publications

Power Shovels — MARION STEAM SHOVEL COMPANY, Marion, Ohio, has devoted a new bulletin, No. 31, to its new diesel electric 1¼-yd. shovel, type 450. The bulletin discusses the advantages and possibilities of the diesel as primary power and describes in turn and in detail the underframe, the crawler units, the mounting of the engine, the electric motor and the control equipment, the motors, the swing equipment and the front end equipment, consisting of boom, dipper stick and dipper. Specifications and working dimensions are given for the machine fitted as a shovel, a clamshell and a dragline.

The Business Side of Construction

Heavy Construction Gains 42 Per Cent Over Last Year

ENGINEERING construction in the first three months of 1929 exceeded last year's value by $351,000,000, or 42 per cent. Building construction (67 per cent of the total) is up 39 per cent, with other construction recording a gain of 47 per cent. Residential construction, which has been falling since December, rose quite sharply in March, bringing the total for the quarter up to $500,000,000, compared with $700,000,000 in the first three months of 1928. Adding engineering and residential construction, the combined volume is 8 per cent above last year.

Streets and roads show the only decline, the value being only one-half of last year's. Private bridges worth $20,000,000 have been let, compared with $7,000,000 last year; public bridges are about the same as a year ago. All three groups of buildings show substantial increases. The tremendous gain of $141,000,000 in private and classified contracts is due to a few extraordinarily large contracts, such as a $45,000,000 oil refinery at Mariner Harbor, N. Y., a $30,000,000 gas pipe line from Monroe, La., to St. Louis, and a $45,000,000 telephone extension in the Southwest. Heavy lettings of buildings and unclassified contracts have boosted private construction far above the value of public contracts, though the latter is about the same as in the first quarter of 1928. The geographic gain is general, though heaviest in the Middle Atlantic States. New England is up 12 per cent; the South 20 per cent.

Contracts in March were let at the rate of $90,000,000 a week, compared with $76,000,000 in March, 1928. Although that month's commercial building contracts included the $40,000,000 structure which will replace the Waldorf-Astoria Hotel and a $20,000,000 office for the Bethlehem Engineering Corporation, the weekly rate of commercial lettings was only $3,000,000 greater than the rate in March, 1928. For other engineering projects the weekly rate was $41,000,000, compared with $30,000,000 a year ago.

Geographically, the month's gain is all in the Middle Atlantic and Middle Western states. The states actually leading in these two groups are New York (by $56,000,000), Illinois (by $34,000,000) and Michigan (by $3,000,000).

U. S. River and Harbor Program for 1929

The following allotments have been made by the Secretary of War to works of river and harbor improvement from available funds provided by the War Department appropriation act approved Feb. 28:

Locality	Allotment
Jamaica Bay, N. Y.	$500,000
East River, N. Y.	750,000
Hudson River, N. Y.	900,000
Newark Bay, Hackensack and Passaic rivers, N. J.	500,000
Delaware River, Philadelphia to sea	3,000,000
Inland waterway from Delaware River to Chesapeake Bay, Del. and Md.	400,000
Baltimore harbor and channels, Md.	275,000
Norfolk harbor, Va.	600,000
Inland waterway, Norfolk, Va.-Beaufort Inlet, N. C.	350,000
Intracoastal waterway, Beaufort to Cape Fear River, N. C.	800,000
Savannah Harbor, Ga.	690,000
St. Johns River, Fla., Jacksonville to the ocean	360,000
Southwest Pass, Miss. River, La.	375,000
Sabine-Noches waterway, Texas	830,000
Houston Ship Channel, Texas	900,000
Mississippi River:	
Between Ohio and Missouri rivers	2,125,000
Between Illinois and Wisconsin rivers	2,000,000
Between Wisconsin River and Minneapolis	1,000,000
Missouri River:	
Kansas City to mouth	5,750,000
Kansas City to Sioux City	1,000,000
Ohio River:	
Lock and dam construction	1,250,000
Open channel improvement	1,259,500
Monongahela River, Pa. and W. Va.	425,000
Allegheny River, Pa.:	
Lock and dam construction	1,105,000
Milwaukee Harbor, Wis.	460,000
Illinois River, Ill.	850,000
St. Marys River, Mich.	1,825,000
Sandusky Harbor, Ohio	280,000
San Pablo Bay and Mare Island Strait, Calif.	255,000
Crescent City Harbor, Calif.	345,000
Coos Bay, Oregon	250,000
Umpqua River, Oregon	340,000
Columbia and Lower Willamette rivers between Vancouver, Wash., and Portland, Ore.	300,000
Hilo harbor, Hawaii	250,000
Kahului harbor, Hawaii	300,000
Nawiliwili harbor, Hawaii	325,000

Prices Steady With Higher Demand

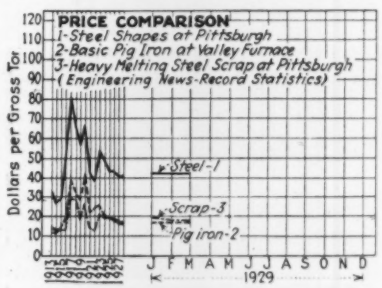
Materials prices have changed little in the last month, and demand has been maintained. The "asking price" of $1.95 for steel shapes remains just that, with sales made at $1.90.

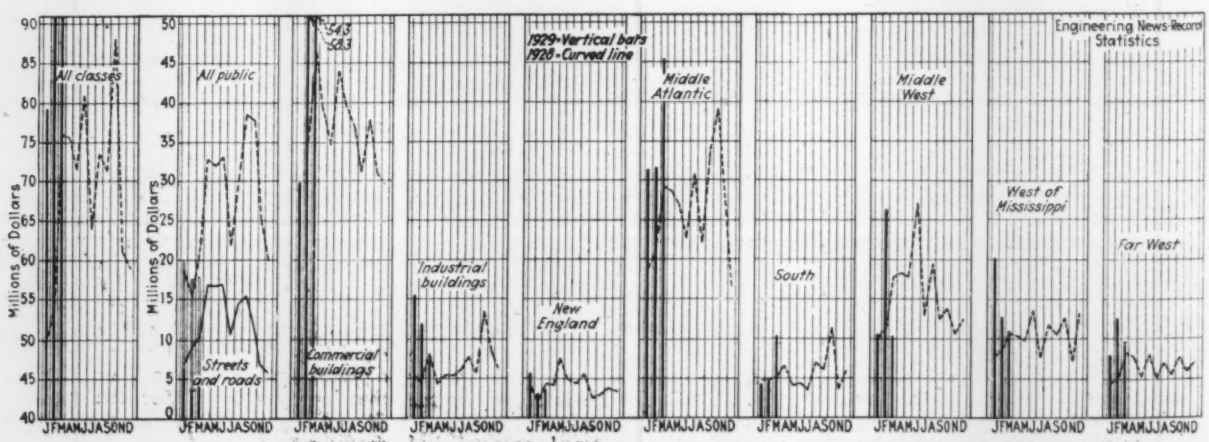
Cement prices remain steady, as usual, only two of the 30 cities reporting changes in March. In Boston the price is $2.30 instead of $2.32½; in Kansas City the price is $2.22 instead of $2.20. This same stability is found throughout the aggregates also.

Brick prices at yards are practically the same as a year ago, and average $11. This price is held to be too low for economic operation of "open" yards, and nearly all these will be out of business by the end of summer. This process should not cause a shortage, and indeed an oversupply is the current complaint. Minneapolis reports the only price change—down 75c., to $12.75.

Lumber production, shipments and orders booked are all well above last year's figures. Price changes show no trend: in Boston, fir is up $1; in Minneapolis both fir and pine are up. There were declines in two cities: fir in Dallas, fir and pine in St. Louis.

For cast-iron pipe the base prices remain the same; but as usual sales have been made at lower figures. San Francisco, for example, paid $43.60.





CONTRACTS AWARDED—AVERAGE WEEK PER MONTH—TOTAL U. S. BY CLASSES—ALL CLASSES BY SECTIONS

Construction Cost and Volume Index Numbers

	E. N.-R. Cost		E. N.-R. Volume*	
Apr.,	1929	203.40	Mar., 1929	382
Mar.,	1929	207.78	Feb., 1929	378
Apr.,	1928	206.40	Mar., 1928	318
Peak June, 1920		273.80	1928 (average)	287
1928 (average)		206.78	1927 (average)	263
1913 (average)		100.00		
1928			1928	
January		203.90	January	208
February		204.65	February	225
March		204.65	March	318
April		206.40	April	316
May		207.00	May	299
June		206.15	June	308
July		206.65	July	266
August		207.29	August	306
September		207.29	September	296
October		207.71	October	363
November		209.46	November	251
December		210.16	December	244
1929			1929	
January		209.40	January	325
February		210.40	February	378

*Corrected for price change since 1913.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type**; declines by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.25@1.40	$0.60@0.70	$0.60@1.00	$0.50	.....	$0.75@1.25	$0.25@.35
Baltimore	1.62½@**1.75**	1.00@1.10	1.37½	1.00	$0.65	1.00@1.25	.35
Barmingham	1.50	1.00	1.25	.50	.....	1.75	*.20@.35*
Bioston	1.50	1.37½	1.37½	.85	1.27½	1.37½	.45@.80
Cincinnati	1.62½	1.37½	1.37½	.97½	1.37½	1.37½	.40@.60
Chicago	1.62½	1.10@1.50	1.00@1.50	.90@.96½	1.50	1.50	.90
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.40@.87½
Dallas	1.67½	1.12½	1.25	*.55@.75*	1.25	1.25	**.35**@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00		1.25	.37½@.62½
Detroit	1.56¼	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.37½@.60
Kansas City	1.50	1.25	1.25	.90	1.25	1.25	**.35**@.75
Los Angeles	1.25	1.00	1.00	.87½	.....	1.00	*.35@.50*
Minneapolis	1.25@1.37½	.87½@.95	.87½	.75	.....	1.00	.40@.50
Montreal	1.25	.75	.75	.40	.....	.90	.30
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.75	1.50	1.75	1.12½	1.00@1.12½	1.75	.90½
Philadelphia	1.62½	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@*.50*
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	.....	1.50	.40@.80
St. Louis	1.75	1.50	1.50	1.15@1.25	1.25	1.50	.40@.75
San Francisco	1.37½	1.12½	1.12½	.87½	1.12½	1.37½	.50@.60
Seattle	1.50	1.12½	1.25	1.00	1.12½	1.25	.70

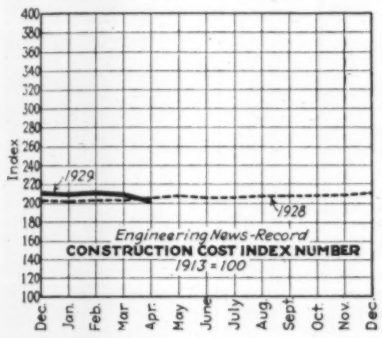
though the formal quotation for that city is $48.

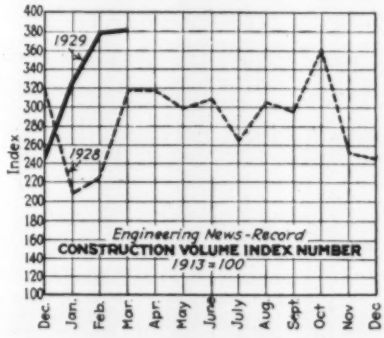
Rising prices in the non-ferrous metals market are having their effect on the cost of paint. Dry red and white lead prices are up 25c. in New York, current quotation being $13.75 per 100-lb. keg. Pig lead rose 67.5c., to $7.62½ per 100 lb., in East St. Louis in March. Linseed oil is down 0.1c. (to 10.9c.) in New York.

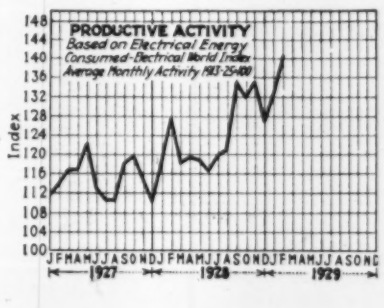
Carpenters Suffer Unemployment

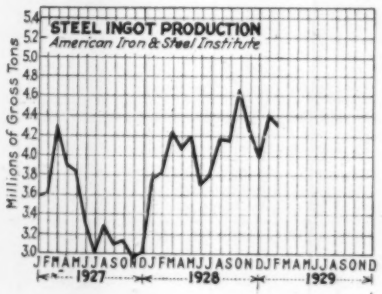
Unemployment rather more than seasonal is reported throughout the building trades. Idleness is particularly severe in the case of carpenters. This is to be expected in view of the 30 per cent slump in residential construction and the increasing substitution of metal forms for wood.

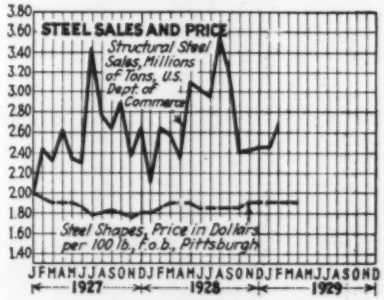
Wage changes were confined to common labor. There were declines in Birmingham, Cleveland, Los Angeles and Philadelphia and advances in Dallas and Kansas City. The average rate is 52.9c., compared with 55.09 a month ago. The average skilled rate is $1.35½, compared with $1.35 in April. These rates compare with factory wages as follows: for unskilled workers, 49c.; for skilled workers, 65.7c.

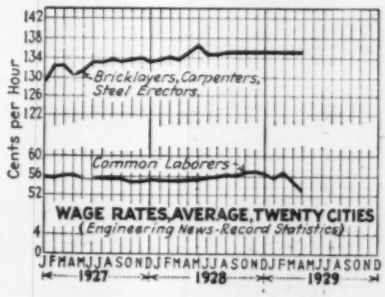


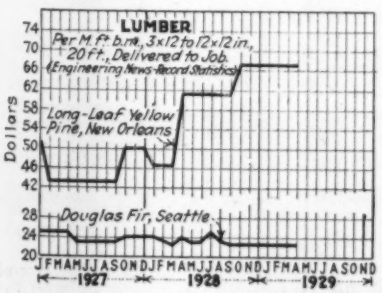


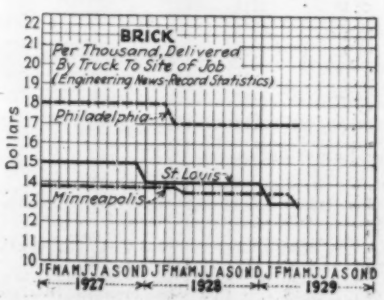

PRODUCTIVE ACTIVITY
Based on Electrical Energy Consumed-Electrical World Index
Average Monthly Activity 1913-25=100
Index
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929

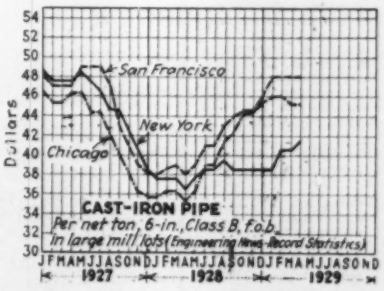

STEEL INGOT PRODUCTION
American Iron & Steel Institute
Millions of Gross Tons
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


STEEL SALES AND PRICE
Structural Steel Sales, Millions of Tons, U.S. Dept. of Commerce
Steel Shapes, Price in Dollars per 100 lb, f.o.b. Pittsburgh
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


Cents per Hour
Bricklayers, Carpenters, Steel Erectors
Common Laborers
WAGE RATES, AVERAGE, TWENTY CITIES
(Engineering News-Record Statistics)
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


LUMBER
Per M ft b.m., 3x12 to 12x12 in., 20 Ft., Delivered to Job.
(Engineering News-Record Statistics)
Long-Leaf Yellow Pine, New Orleans
Douglas Fir, Seattle
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


BRICK
Per Thousand, Delivered By Truck To Site of Job
(Engineering News-Record Statistics)
Philadelphia
St. Louis
Minneapolis
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929


San Francisco
New York
Chicago
CAST-IRON PIPE
Per net ton, 6-in., Class B, f.o.b. in large mill lots (Engineering News-Record Statistics)
Dollars
J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J J A S O N D
1927 1928 1929

COST AND VOLUME INDEXES, MATERIALS PRICES, STEEL PRODUCTION

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per bbl., quoted by manufacturers and dealers, delivered by trucks to contractors, *without charge for bags*. Cash discount not deducted.

	Apr. 4, 1929	One Month Ago	One Year Ago
Atlanta	$2.25	$2.25	$2.30
Baltimore	2.65	2.65	2.54
Birmingham	2.60	2.60	2.60
Boston	2.25@2.35	2.25@2.40	2.25
Cedar Rapids (f. o. b.)	2.24	2.24	2.24
Chicago (f. o. b.)	2.05	2.05	2.25
Cincinnati (f. o. b.)	2.22	2.22	2.22
Cleveland (f. o. b.)	2.24	2.24	2.24
Dallas	2.15	2.15	2.40
Davenport (f. o. b.)	2.24	2.24	2.24
Denver	2.55	2.55	2.85
Detroit (f. o. b.)	1.95	1.95	1.90
Duluth (f. o. b.)	2.04	2.04	2.04
Indianapolis, (f. o. b.)	2.09	2.09	2.19
Jersey City	2.25	2.25	2.13
Kansas City, Mo.	**2.22**	2.20	2.50
Los Angeles	2.76	2.66	2.60
Milwaukee (f. o. b.)	2.20	2.20	2.20
Minneapolis (f. o. b.)	2.22	2.22	2.22
Montreal (f. o. b.)	1.70	1.70	1.41
New Orleans	2.65	2.65	2.50
New York	2.25	2.25	2.25@2.35
Peoria (f. o. b.)	2.22	2.22	2.22
Philadelphia	**2.40**	2.40	2.21
Pittsburgh (f. o. b.)	2.05	2.05	2.04
St. Louis	2.45	2.45	2.45
St. Paul (f. o. b.)	2.22	2.22	2.22
San Francisco	2.41	2.41	2.41
Seattle	2.70	2.70	2.65
Toledo (f. o. b.)	2.20	2.20	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Leeds, Ala.	$1.65
Buffington, Ind.	1.80	Lehigh Valley District	1.75
Clinchfield, Ga.	1.65	Mason City, Ia.	1.80
Fordwick, Va.	2.05	Mitchell, Ind.	1.90
Hannibal, Mo.	1.90	North Birmingham, Ala.	1.45
Hudson, N. Y.	1.75	Richard City, Tenn.	1.85
Iola, Kan.	1.85	Steelton, Minn.	1.85
Kingsport, Tenn.	2.05	Universal, Pa.	1.80
La Salle, Ill.	1.90	Wyandotte, Mich.	1.70

SAND AND GRAVEL—Dealers' quotations per cu.yd. delivered. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd., unless otherwise specified in pounds.

	Gravel		Sand
	1½ In.	¾ In.	
Atlanta, per ton	$3.50	$3.50	$2.40
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600 lb.)	3.00	3.00	2.65
Boston, per ton	2.00	2.00	1.50
Chicago	*2.10*	*2.10*	*2.10*
Cincinnati, per ton	1.90	1.90	1.60
Cleveland	2.60	2.60	2.50
Dallas	**2.50**	**2.50**	2.25@**2.60**
Denver (2,700 lb.)	1.80	1.80	1.30
Detroit (2,600 lb.)	3.25	3.25	2.75
Kansas City, Mo.	.....	.....	.....
Los Angeles, per ton	2.15	2.15	1.30
Minneapolis (2,800 lb.) (3,000 lb.)	2.40	2.40	1.25
Montreal, per ton	1.90	1.50	1.20
New Orleans (2,700 lb.) (2,500 lb.)	3.75	3.75	2.75
New York	3.25	3.25	2.00
Philadelphia, per ton	2.30@3.15	2.30@3.15	1.50@2.31
Pittsburgh, per ton	2.40	2.40	2.60
St. Louis, per ton	2.35	2.25	2.00
San Francisco (2,800 lb.)	1.75	1.75	1.50
Seattle (3,200 lb.) (2,850 lb.)	2.00	2.00	2.00

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Dealers' quotations per cu.yd., delivered. Weight, 1½ tons per cu.yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	$3.50	$3.50
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	3.00	3.25
Boston, per ton	2.40	2.40
Chicago, Limestone	*2.10*	*2.10*
Cincinnati, per ton	2.50	2.50
Cleveland, per ton	2.70	2.70
Dallas	3.25	3.40
Denver, Granite (2,700 lb.)	2.50	2.50
Detroit, Limestone, per ton	3.00	3.00
Kansas City, Limestone, (2,450 lb.)	2.00	2.00
Los Angeles, per ton	**2.15**	**2.15**
Minneapolis, Limestone (2,600 lb.)	2.40	2.40
Montreal, per ton	2.10	2.10
New York, Limestone	3.25	3.25
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	2.75	2.75
St. Louis, per ton (2400 lb. per cu.yd.)	**2.00**	**2.00**
San Francisco, Trap rock (2,400 lb.)	1.65	1.65
Seattle, (2,700 lb.)	1.90	1.90

CRUSHED SLAG—Manufacturers' quotations on crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala.	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.30	1.30	.....	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Dealers' quotations on hollow building tile per block, delivered to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.075	$0.104	$0.142	$0.189	$0.21
Baltimore	.105	.....	.20	.....	.26
Birmingham	.09	.127	.174	.218	.261
Boston	**.085**	**.11**	**.15**	**.1875**	**.255**
Chicago	.076	.104	.142	.182	.202
Cincinnati	.074	.105	.136	.175	.205
Cleveland	.064	.088	.128	.171	.19
Dallas	.096	.12	**.1785**	.284	.....
Denver	.0975	.135	.175	.2125	.25
Detroit	.096	.132	.18	.235	.261
Kansas City	.0525	.077	.158	.....	.242
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0675	.0845	.131	.134	.1896
Montreal	.12	.....	.22	.....	.315
New Orleans	.086	.125	.162	.212	.247
New York	.0864	.1296	.162	.....	.....
Perth Amboy, N.J. (f.o.b.)	.....	.....	.....	*.2388*	*.2956*
Philadelphia	.11	.145	.22	.27	.34
Pittsburgh	.068	.....	.1175	.....	.1726
St. Louis	.078	.105	.145	.175	.21
San Francisco	.108	.156	.255	.....	.....
Seattle	.08	.11	.18	.....	.....

BRICK—Dealers' quotations, delivered, per thousand are as follows:

		Paving	
	Common	3x8½x4-in.	3½x8½x4-in.
Atlanta	$14.75	$38.00*	$45.00†
Baltimore	14.00	40.00	**46.00**
Birmingham	15.00	32.00*	36.00†
Boston	17.00	43.50	50.00
Chicago	12.00	42.00	45.00
Cincinnati	18.00	40.00	45.00
Cleveland	14@16	33.00	36.00
Dallas	15.00	35.00	.....
Denver, salmon	12.00	.....	.....
Detroit	15.50	*34.14*	*38.27*
Kansas City	16.00	.....	.....
Los Angeles	11.00	.....	.....
Minneapolis	*12.75*	.....	.....
Montreal	20.33	.....	.....
New Orleans	16.50	40.00*	50.50
New York	15@16	45.00	51.00
Philadelphia	17.00	40.00	46.00
Pittsburgh	17.00	40.50	45.00
St. Louis, salmon	13.00	40.00	45.00
San Francisco	14.50	40.00	45.00
Seattle	14.00	50.00	55.00

*2½x8½x4 in. †3x8½x4.

LIME—Dealers' quotations, delivered to job:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
Atlanta	$27.50	$17.50	.....	.....
Baltimore	20.00	14.00	$2.55†	.....
Birmingham	22.00	16.00	3.00†	$2.00†
Boston	21.00	14.50	3.80*	2.90*
Chicago	17.00	15.00	17.00‡	1.50†
Cincinnati	18.00	13.20	.....	13.20‡
Cleveland	20.00	16.00	2.50†	2.50†
Dallas	20.00	.....	.....	18.00‡
Denver	32.00	23.75	3.80*	3.00*
Detroit	19.20	14.80	2.20†	2.20†
Kansas City	24.00	13.00	2.75†	2.75†
Los Angeles	25.00	18.00	2.85†	17.00‡
Minneapolis	25.50	21.00	.....	1.70†
Montreal	.....	19.75	.....	15.00‡
New Orleans	.....	.....	2.60†	1.60†
New York	21.00@22.00	14.00@15.00	4.00@4.10*	3.15@3.25*
Philadelphia	22.00	15.00	.....	.....
Pittsburgh	*20.00*	*18.00*	.....	.....
St. Louis	24.00	18.00	2.75†	.....
San Francisco	27.50	20.00	.....	1.70†
Seattle, paper sacks	36.00	24.00	.....	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.18@.20	Minneapolis, f.o.b.	$0.13
Brooklyn and Queens	*.15@.16*	New Orleans	.22
Cleveland	*.16@.17*	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Roofing, genuine Bangor, f.o.b., quarry, Bangor, Pa., per square:

No. 1 Clear	**$10.50@$14.00**
No. 1 Ribbon	**9.00@ 10.25**
Medium Clear	**9.50@ 11.25**

Road and Paving Materials

PAVING STONE—Dealers' quotations, f.o.b., in carloads or in cargo lots, for granite blocks, 4x8x4-in., dressed:

Atlanta	$3.00 per sq.yd.
Baltimore	3.00 per sq.yd.
Boston	135.00 per M
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.50 per sq.yd.
Minneapolis, Sandstone, 4½x8x5 in.	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd.	150.00 per M.
Philadelphia	125.00 per M.
St. Louis, 4x5x8 to 12 in.	3.50 per sq.yd.
San Francisco, Basalt block, 4x7x8 in.	70.00 per M.

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Dealers' quotations, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	**2.45**
Chicago	3½	16	2.10
Cincinnati	3½	16	2.35
Dallas	4	18	3.90
Kansas City	3½	16	2.50
Minneapolis	3½	16	2.75
Montreal	4	16	4.50
New Orleans	3½	16	2.25
New York	3½	16	2.70
St. Louis	3½	16	2.35

FLAGGING—Dealers' quotations, alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 26c. per sq.ft.

CURBBING—Dealers' quotations: *New York*: Bluestone, f.o.b. barge, New York, 5x16 in., rough, 90c. per lin.ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, 5x16 in., f.o.b., **$1.10** per lin.ft.; roundings, **$1.60** per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls. or 425-lb. drums); also in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
Atlanta (Mexican)	$22.55	$18.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	23.00
Boston (Mexican)	*24.00*	*18.00*
Chicago (Texas)	24.50	21.30
Cincinnati (Kentucky Rock)		12.30
Cleveland	24.00	20.00
Dallas (Texas)	**27.85**	
Denver (California)	35.00	
Detroit (Mexican)	*19.75*	*15.20*
Kansas City, Mo. (Texas)	**30.00**	25.00
Los Angeles ("D" Grade, Calfornia, f.o.b., El Segundo)	18.00	12.90
Maurer, N. J. (Bermudez)	30.00	
Maurer, N. J. (Trinidad)	25.00	
Minneapolis, (Stanolind, f.o.b., Twin Cities)	*24.10*	19.10
Montreal (Imperial)	28.00	21.50
New Orleans (Texas)	24.00	21.00
New York (Texas)	22.50	18.50
Philadelphia (Mexican)	20.00	18.00
Pittsburgh (Standard Oil)	*22@24*	*16@18*
St. Louis (Mexican)	23.50	19.50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, California, f.o.b., Richmond refinery)	19.50	13.50

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	.0525
Dallas, 40@50% asphalt	**.065**
Dallas, 50@60% asphalt	**.065**
New York, 40@50% asphalt (at terminal)	.06
New York, 50@60% asphalt (at terminal)	.06
St. Louis, 40@50% asphalt	**.042**
St. Louis, 50@60% asphalt	**.052**

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 1.75@2.25	*$15.50@$16.00*
Pittsburgh, basic, incl. freight ($1.76) from Valley	19.26

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	**3.60**	**3.60**
New York, warehouse, delivered, up to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b., (Mar. 28, 1929)	1.90	1.90
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.15	3.15

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations on bars rolled from billets, per 100 lb. for ½-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.30@3.00
Cleveland, warehouse, delivered	*2.25@2.44*
Dallas, warehouse, delivered	*3.25*
New York, warehouse, delivered, over 5 tons	2.85
Pittsburgh, large mill lots, stock lengths, f.o.b.	2.00
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Dealers' quotations per 100 sq.yd., painted, delivered to job in less-than-carload lots:

Lb. per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$15.00	$19.00	$14.00	$18.00	$21.50	$16.00
2.5	16.00	20.00	15.00	19.00	24.00	17.00
3.0	17.50	22.50	16.50	21.00	.....	19.50
3.4	20.00	24.50	18.00	22.50	30.00	21.50

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and dealers, delivered in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse Delivery: New York	St. Louis	Dallas*	San Francisco*
032	22	$0.99	$1.01	$1.39	$1.30	$1.13	$1.22
049	28	1.26	1.29	1.76	1.70	1.38	1.55
068	35	1.54	1.58	2.18	2.10	1.67	1.91
093	40	1.98	2.03	2.79	2.65	2.09	2.46
126	57	2.45	2.51	3.45	3.30	2.55	3.03
153	68	2.92	2.99	4.13	3.95	3.15	....
180	78	3.35	3.43	4.73	4.50	3.47	....

*...t w...r house.

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb., base size.

	Blue Annealed No. 10	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35	$3.80	$4.65
Cleveland, warehouse, delivered	3.25	3.60	4.45
New York, warehouse, delivered	3.90*	4.00	4.75
Pittsburgh, large mill lots, f.o.b.	2.10@**2.20**	2.85@**2.95**	3.60@**3.70**
St. Louis, warehouse, delivered	3.45	4.10	4.95
San Francisco, warehouse, delivered	3.80	4.90	5.30

*Up to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
Special steel round strand rope	30%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations on structural rivets, round-head, ½-in., full kegs, per 100 lb.:

Chicago, warehouse, delivered	$3.60
Dallas, warehouse, delivered	*4.50*
New York, warehouse, delivered	4.50*
Pittsburgh, large mill lots, f.o.b.	**3.10**
St. Louis, warehouse, delivered	3.75
San Francisco, warehouse, delivered	5.75
Seattle, warehouse, delivered	3.75

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill, per package $11.20

SHIP SPIKES—Dealers' quotations per 100 lb., black, from warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	½-In	⅝-In	¾-In
San Francisco	$5.55	$5.10	$4.95
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Dealers' quotations per 100 lb. keg, base, delivered from warehouse stocks, also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$2.75	$3.30	$3.15	$3.05	*$1.75*	$3.35	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	$12.50@$13.00	**$16.00@$16.50**	$15.00
Stove plate	**9.00**@ 9.50	15.00@ 15.50	10.50@ 11.00*
No. 1 machinery cast	15.00@ 17.00	17.50@ 18.00	**14.00***
Machine shop turnings	*7.75@ 8.00*	*8.00@ 8.50*	*7.25*
Cast borings	*7.00@ 7.25*	*10.00@ 10.50*	*9.25*
Railroad malleable	**14.00@ 14.50**	19.00@ 19.50	13.00
Re-rolling rails	13.50@ **14.00**	17.50@ 18.00	16.00
Re-laying rails, 56@60 lb.	23.00@ 24.00	23.00@ 25.00	.....
Heavy melting steel, No. 1	**12.85@ 13.50**	15.75@ 16.25	*14.50*
Iron and steel pipe	11.75	12.00@ 12.50	9.00

*Net ton.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71*
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15†
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15†		

*Except iron or steel pipe and fittings. †Minimum weight on structurals, 60,000 lb.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mil lots:

	Pittsburgh	Birmingham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb.	36.00	34@36	34@36
Re-rolled rails	34.00	34@36	34@36

RAILWAY TIES—Dealers' quotations, f.o.b., for fair-sized orders:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	Southern pine, untreated	1.10	1.25
	Southern pine, creosoted	1.60	1.75
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	1.20	1.70
	Red oak, creosoted	.60	2.10
	Sap pine or cypress, untreated	1.00	*1.45*
San Francisco	Douglas fir, green, untreated	.82	1.14
	Douglas fir, empty cell, creosoted	1.73	2.32
Montreal	Birch or maple, untreated	.75@1.25	.75@1.25
	Birch or maple, creosoted	1.20@1.30	1.50@1.60

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb., f.o.b. Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, ⅝-in. and larger	$2.80	$3.55	$3.50	$3.55@$3.70	$3.85
Track bolts	3.80	4.55	4.50	4.55@4.75	4.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.50	.....	.....

Tie plates: Price at Pittsburgh and Chicago mills, $2.15 per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers' standard lists:

	1 to 3-In. Butt Weld		2½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	54%	41%	51%	38%
Cleveland, warehouse, delivered	55½%	43½%	53½%	40½%
New York, warehouse, delivered	50%	36%	45%	32%
Pittsburgh, large mill lots, f.o.b.	62%	50½%	59%	47½%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S. Cast Iron Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots of pipe:

	4-In.	6-In. and Over
Birmingham mill	$41.00	$38.00
Burlington (N. J.) mill	42.00	39.00
Chicago	49.20	46.20
New York	44.60	41.60
Pittsburgh	49.50	46.50
St. Louis	46.60	43.60
San Francisco	51.00	48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Dealers' quotations, delivered, in cents per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.20	$0.34	$0.75	.....	$1.93	.....	$6.50
Baltimore	.16	.30	.58	.....	2.15	3.50	5.90
Birmingham	.25	.40	.65	$1.50	2.75	$3.90	5.83
Boston	.18	.29	.54	1.25	2.15	3.50	5.90
Chicago	.15	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.144	.224	.432	.80	1.44	2.304	4.8175
Cleveland	.18	.28	.54	1.30	2.34	4.68	7.18
Dallas	.256	.42	.794	1.70	3.00	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	.21	.29	.52	.....	1.90	3.80	.....
Los Angeles	.21	.2825	.51	1.186	2.03	3.39	5.09
Minneapolis	.16	.25	.50	1.15	1.84	3.49	4.97
Montreal	.36	.53	.78	1.48	2.75	4.20	.....
New Orleans	.18	.30	.54	1.02	1.95	.....	.....
New York	.185	.29	.56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	.351	1.025	1.845	3.60	5.6375
Pittsburgh	.0945	.147	.2835	.85	1.53	3.024	4.8175
St. Louis	.1645	.182	.468	1.092	1.872	3.65	4.80
San Francisco	.21	.30	.54	1.26	2.16	3.60	.....
Seattle	.22	.30	.54	1.26	2.16	3.60	.....

CLAY DRAIN TILE—Dealers' quotations, delivered, per 1,000 lin.ft.:

Size, In.	New York	Birmingham	St. Louis	Dallas	San Francisco	Seattle
3	$45.00	$45.00	$50.00	.....	.....	$45.00
4	55.00	56.00	55.00	$73.00	$67.50	60.00
5	85.00	80.00	85.00	110.00	86.25	.....
6	112.00	105.00	112.00	120.00	112.50	112.00
8	135.00	175.00	195.00	150.00	187.50	.....

Miscellaneous

LINSEED OIL—Dealers' quotations on raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York....$0.109 Chicago....$0.114 Minneapolis....$0.119

WHITE AND RED LEAD—Dealers' quotations per 100-lb. keg, base price, f.o.b., New York: White, dry or in oil, $13.75; Red, dry, $13.75; Red, in oil, $15.25.

CHEMICALS—Water and sewage treatment chemicals, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb	6.20@6.40
Soda ash, 58%, in bags, per 100 lb	1.32@1.35
Chlorine, cylinders, per lb	.05@.08
Bleaching powder, in drums, f.o.b. works, per 100 lb	2.00@2.10

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ¾-in., 8-ft.; ⅞-in., 6-ft.; 1-in., 4½-ft.; 1-in., 3¼-ft.; 1¼-in., 2-ft., 10-in.; 1½-in., 2-ft. 4-in. Following are dealers' quotations per pound for ¾-in. and larger, delivered in 1,200-ft. coils:

Atlanta	$0.21	Kansas City	$0.29
Baltimore	.22½	Los Angeles	.25
Birmingham	.26	Minneapolis	.24
Boston	.235	Montreal	.24½
Chicago	.22	New Orleans	.23½
Cincinnati	.21	New York	.21
Cleveland	.21	Philadelphia	.24
Dallas	.20	San Francisco	.20½
Denver	.23	Seattle	.20½
Detroit	.24	St. Louis	.19½

ROOFING MATERIALS—Dealers' quotations, f.o.b., New York, to contractors in carloads:

Asphalt felt, per 100 lb	$2.60
Tar felt, per 100 lb	2.60
Asphalt coating, per gal	.34½
Tar pitch, in 350 lb. barrels, per ton	28.00

PREPARED ROOFINGS—Dealers' quotations to contractors, in carloads, f.o.b New York.

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$6.12½
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

WINDOW GLASS—United inches 25, brackot size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses:

AA .....83% A .....86% B.....88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots, under 200 lb.

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.1925	.2125
Birmingham	.22	.245	Montreal	.195	.22
Boston	.23	.25	New Orleans	.195	.22
Chicago	.195*	.22*	New York	.255‡	.2775‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.1825	.218	St. Louis	.215	.235
Denver, f.o.b.	.19	.2125	San Francisco	.1625	.1925
Kansas City, Mo.	.2025	.2225	Seattle	.16	.185

*Quantities above 500 lb. but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

San Francisco—Dealers' quotations on rough Douglas fir, No. 1 common, at yards. For delivery to contractor at site of job, add $1.50 to $5 per M. ft.:

	10-16-18 and 20 Ft.	22 and 24 Ft.
3x3 and 4	$28.00	$29.00
3x6 and 8	28.00	29.00
3x10 and 12	28.00	29.00
3x14	31.00	33.00

Chicago—Dealers' quotations, f.o.b., in carloads, No. 1 Common, rough, per M. ft. b.m. For delivery to job from stock, in truckloads, add $10 per M. ft.:

	20 Ft. and Under Long-Leaf Yellow Pine	Up to 32 Ft. Douglas Fir
3x4 to 8x8	$41.00	$42.00
3x10 to 10x10	48.50	42.00
3x12 to 12x12	58.50	42.00
3x14 to 14x14	70.50	43.00

New York—Quotations per M. ft., b.m., wholesale, for long-leaf, yellow-pine timbers, No. 1 common, rough, in quantities of 35,000 ft. or more, within lighterage limits:

	20 Ft. and Under	22 and 24 Ft.
3x4 to 8x8	$43.00@$45.00	$44.00@$46.00
3x10 to 10x10	50.00@52.00	51.00@55.00
3x12 to 12x12	57.00@59.00	58.00@60.00
3x14 to 14x14	65.00@67.00	66.00@68.00

Other Cities—Dealers' quotations, delivered, No. 1 Common, rough, per M. ft:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine*	Fir†	Hemlock	Spruce	Pine*	Fir†
Atlanta	$47.50	.....	.....	.....	$67.50	.....
Baltimore	36.00	$50.25	$54.00	$61.00	75.00	$50.25
Birmingham	45.00	.....	.....	.....	60.00	.....
Boston	48.00	47.00	47.00	47.25	57.00	51.00
Cincinnati	38.00	49.00	47.00	47.00	42.00	53.00
Cleveland	65.00	65.00	.....	.....	65.00	65.00
Dallas	65.00	52.50	57.50	.....	65.00	52.50
Denver	.....	57.00	57.00	55.00	.....	55@58
Detroit	62.50	51.50	.....	.....	68.50	51.50
Kansas City, Mo.	42.80	39.75	.....	.....	57.50	39.75
Los Angeles	.....	44.00	.....	.....	.....	38.00
Minneapolis	58.00	53.25	38.25‡	.....	58@60	53.25@54.75
Montreal	50.00	55.00	.....	.....	49.00	48.00
New Orleans	50.00	46.00	.....	44.00	67.00	63.00
Philadelphia	52.00	35.00	42.00	40.00	55.00	35.00
St. Louis	45.00	38.00	.....	.....	54.00	39.50
Seattle	.....	22.50	.....	.....	.....	22.50

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hemlock	Pine*	Fir†
Atlanta	$60.00	.....	.....	$40.00	.....
Baltimore	56.00	$45.00	$45.00	.....	.....
Birmingham	36.00	.....	.....	43.00	.....
Boston	44.00	43.00	42.00	48.00	$47.75
Cincinnati	35.00	40.00	33.00	35.00	48.00
Cleveland	60.00	55.00	.....	65.00	58.00
Dallas	60.00	.....	.....	.....	.....
Denver	.....	46.00	46.00	.....	50.00
Detroit	45.00	42.00	.....	47.50	45.00
Kansas City, Mo.	50.50	45.75	.....	44.75	36.75
Los Angeles	.....	44.00	.....	.....	57.00
Minneapolis	53.00	47.00	39.75‡	51.00	46.00
Montreal	56.00	48.00	40.00	85.00	70.00
New Orleans	43.00	40.00	.....	50.00	46.00
Philadelphia	55.00	36.50	36.00	52.00	36.50
St. Louis	41.50	38.00	37.00	37.00	34.00
Seattle	.....	20.00	.....	.....	22.00

*Long-leaf yellow pine. †Douglas fir. ‡f.o.b.

PILES—Dealers' quotations per lineal foot, pine, with bark on, f.o.b., New York:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41